

Interventions/Outcomes Involving Teacher Leaders' Strategy of Lesson Planning

Excerpted from Balfanz, R., MacIver, D.J., Byrnes, V. (2006) The implementation and impact of evidence-based mathematics reforms in high-poverty middle schools: A multi-site, multi-year study. *Journal for Research in Mathematics Education*, 37(1), 33-64.

This article reports on the first 4 years of an effort to develop and implement a comprehensive and sustainable set of evidence based curricula, professional development, and supportive whole school reforms aimed at raising mathematics achievement in high poverty middle schools. Four related analyses examine the levels of implementation achieved and impact of the reforms on various measures of achievement in the first 3 schools to implement the Talent Development (TD) Middle School Model's mathematics program that combines coherent research-based instructional materials from the University of Chicago School of Mathematics Project with a multi-tiered teacher support system of sustained professional development and in-class coaching. The first section of the article reviews the evidentiary basis for the enacted reforms, describes them, and provides information on the schools that participated in the study. The results of the study (the level of implementation achieved and the impact of the reforms on multiple measures of mathematics achievement) are detailed in the second section. The final section discusses the overall impact of the reforms and explores additional steps needed to achieve high levels of mathematical learning in high poverty middle schools.

A moderate level of implementation was achieved. TD students outperformed students from control schools on multiple measures of achievement. The average effect size, Δ , by the end of middle school was .24.

All of the middle schools in the study are large non-selective neighborhood schools that serve low-income minority populations in the School District of Philadelphia.

Intervention: A central feature of the TD Mathematics Program was the school-wide use of research-based instructional materials. In Grades 5 and 6, the schools implemented Everyday Mathematics, from the University of Chicago School Mathematics Project (UCSMP) elementary curriculum; in Grade 7, they used UCSMP *Transition Mathematics*; and in Grade 8, UCSMP *Algebra*. One of the three middle schools participating in the project was attempting to teach all students algebra in eighth grade, and one teacher at the school was already using the UCSMP series, so in this school the UCSMP *Algebra* text was adopted school wide during the 1st year of implementation. The other two schools phased in the *Algebra* text over a 3-year period in order to allow time to build both student and teacher skills. In these two schools, both seventh and eighth graders used the UCSMP *Transition Mathematics* text during the 1st year of implementation. During the 2nd year, eighth graders completed units from the last half of the *Transition Mathematics* text and the first half of the *Algebra* text. In year 3, the *Algebra* text was used from the start of eighth grade. All three schools introduced

Everyday Mathematics Grades 5 (in the two 5-8 schools) and Grades 6 in the 1st year of implementation. Thus, by the start of year 3, all three schools were offering all students the same mathematics curriculum and sequence of courses, culminating with all students taking an algebra course using a challenging *Algebra* text in the eighth grade.

Teachers were offered multiple tiers of professional development linked to the implementation of the new mathematics curriculum. Three days of summer training were followed by monthly 3-hour workshops on Saturdays. Make-up sessions were offered during the week after school. In all, teachers had access to over 36 hours of professional development per year. Following the union contract attendance was voluntary, and teachers were paid the district rate for attending training outside the school day (approximately \$20 per hour). Beginning in the 2nd year, arrangements were made with a local university to give teachers three graduate course credits if they completed 36 hours of training and related assignments. The goal was to provide teachers much more professional development than has been typically received by most mathematics teachers in the United States.

From the start, experienced peer teachers and users of the curricula led the professional development workshops. The sessions were grade specific and focused on the unit or lessons the teachers would be using during the following month. Those leading the sessions typically previewed and modeled key activities, reviewed core content knowledge and discussed appropriate classroom management strategies.

In addition to monthly professional development sessions, teachers had access to in-classroom implementation support from a curriculum coach. Each school was assigned a curriculum coach who spent 1 to 2 days per week in each school working with teachers in their classrooms. Implementation support was nonjudgmental and varied from classroom to classroom but included modeling, explaining, and co teaching, assisting with lesson planning, observing lessons and providing confidential feedback, and making sure that the teacher had all the materials needed to implement the lesson. The curriculum coach also worked with the teacher to make modifications to the curriculum based on the needs of the classroom. Overall, the coach's job was to do what it took to provide teachers with the support they needed to achieve strong implementation in their classrooms.

During the 3rd year of the effort, an initiative was started to train two to three teacher leaders from each school to be on-site trainers and implementation support personnel, with the goal of making the schools self-sustaining over time. These teacher leaders received an additional 30 hours of training per year for 2 years and provided an additional layer of support in the schools. In each school, two teacher leaders were successfully recruited and completed the 2-year training sequence, which included both professional development sessions devoted to specific topics like assessment, student engagement, and mathematical discourse, as well as opportunities to shadow curriculum coaches as they worked with teachers, engaged in lesson study, and led professional development sessions.

Each summer, the teachers were invited to work in summer work groups to develop supplemental materials to help further customize and localize the instructional materials. During the first 2 summers, four two-teacher teams developed sets of teacher notes for each unit that provided instructional and organizational tips, pacing guides, and extra-practice problem sets and homework books. During the 3rd summer, September Introductory Units were developed. These units are designed to compensate for the “broken supply lines” found in many urban schools at the start of most school years.

Excerpted from Cruz, D. (2003). Teacher leaders: Middle school mathematics classrooms. *Research in Middle Level Education Online*, 26(2) p10-27

This study examined the characteristics and behaviors of middle school mathematics teacher leaders in their classrooms. Data were collected from four separate school districts.

Interviews were conducted in conjunction with ethnographic observation. The Teacher Roles Observation Schedule (TROS) instrument was used to record observations of a teacher leader's classroom behavior. The instrument provided ten intervals for ten separate observations. The observer watched the teacher leader for ten separate 60-second intervals and recorded as many teacher interactions, settings, purposes, and natures of teacher inactions as possible. Teachers were observed non-continuously to facilitate a wider sample of observations.

The questionnaire used the peer nomination technique. Middle school mathematics teachers were asked to recommend a peer who he or she felt was a teacher leader in the middle school mathematics classroom. Furthermore, the teacher was asked to specify the characteristics that made his or her nominee a teacher leader.

Questionnaires were sent to middle school mathematics teachers in four school districts. Sixty-three teachers responded for a response rate of 56%.

There were 20 teachers who were nominated as teacher leaders in the middle school mathematics classrooms. Upon contact, three of the 20 teachers declined to be involved with the study. Two of the remaining 17 were in school district leadership positions related to district mathematics professional development and curriculum management. These two were no longer in the classroom and were unable to respond to a majority of the interview's items.

Excerpted from Gigante, N.A., Firestone, W.A. (2007). Administrative support and teacher leadership in schools implementing reform. *Journal of Educational Administration*, 46(3), 302-325.

This paper aims to explore how teacher leaders help teachers improve mathematics and science teaching. Research focused on a purposive sample of seven teacher leaders selected to vary in their time allocated to teacher leader work and their content knowledge. Each teacher leader was interviewed, as were two teachers and at least one administrator working with that teacher leader. Each interview was first subjected to a mix of deductive and inductive coding before a case study was written for each teacher leader. Teacher leaders conducted two sets of leadership tasks. The paper finds that support tasks helped teachers do their work but did not contribute to teacher learning. Developmental tasks did facilitate learning. All teacher leaders engaged in support tasks, but only four did developmental tasks as well. Teacher leaders who engaged in developmental tasks had access to one material resource and three social resources not available to other teacher leaders: time to work with teachers, administrative support, more positive relations with teachers and opportunities to work with teachers on professional development.

Methods

This study is part of a larger study of teacher leadership undertaken in the context of the implementation of the New Jersey Math Science Partnership. The New Jersey Math Science Partnership (NJ MSP) was a collaboration among two universities and 11 school districts to improve students' achievement in mathematics and science across all grade levels. An important theme of the partnership was to strengthen organizational support of inquiry-oriented instruction. One way to do that was to conduct summer institutes for teacher leaders. In conjunction with these institutes, the NJ MSP encouraged partner districts both to integrate teacher leaders into their school improvement planning and to provide teacher leaders with the support needed to effectively sustain such improvement.

This study was conducted in a qualitative research tradition, specifically as a comparative case study using a naturalistic approach (Marshall and Rossman, 1999). Information about teacher leaders' work and the organizational factors influencing teacher leaders' roles was collected from teacher leaders and other informants in the setting. Interaction with these participants in their naturalistic settings helped to better understand the situational factors at play within these contexts (Spillane et al., 2001).

Sample

The population from whom the sample was taken was the group of teacher leaders who participated in the 2004 Teacher Leader Institute (TLI). Purposeful sampling (Patton, 1990) was used to select the teacher leaders who would be "information rich" in terms of this particular study, three colleagues of each, and both the district administrator and building administrator of each. The teacher leader's description of whom he/she most closely worked with determined the persons contacted for

interviews at each level. Each teacher leader provided names of his/her colleagues, three of whom were contacted for interviews.

This study was part of a larger investigation of teacher leadership by the NJ MSP. The larger study called for selecting teacher leaders who vary on two dimensions. The first was the amount of time teacher leaders are formally released to work with their colleagues. In previous studies, release time has been a substantial influence on the success or failure of a teacher leadership initiative (Lord and Miller, 2002). Release time affected teacher leaders' opportunity to interact with their colleagues as part of their teacher leadership work. The other dimension on which teacher leaders were sampled was their content expertise (see Table I).

Seven teacher leaders from the 11 NJ MSP school districts who participated the TLIs during the summer of 2004 were chosen for this study. Three of these seven participated in the 2003 TLI and a pilot study conducted that year; therefore, in these three cases, longitudinal data were utilized. All the teacher leaders worked with teachers in kindergarten through grade eight. Six teacher leaders came from school districts that were among the poorest in the state. Five of these districts had student bodies that were predominantly Hispanic. The seventh teacher leader came from a district that was in the middle of the state's income distribution and was predominantly white.

In addition to the teacher leaders, information was obtained from 19 colleagues of the teacher leaders (one to three for each of the seven teacher leaders) and 13 administrators with whom the teacher leaders worked (one was the district administrator for two of the seven teacher leaders). Some colleagues and administrators whose names teacher leaders provided to the researchers did not return calls and/or e-mails requesting their participation. In addition, one teacher leader in the non-content expert/no release time category requested that the researcher not speak to her building administrator.

Excerpted from Hofstein, A., Carmeli, M., & Shore, R. (2004). The professional development of high school chemistry coordinators. *Journal of Science Teacher Education*, 15(1), p3-24

In the Israeli education system, each school has a coordinating teacher for each of the disciplines. A program that was designed for the professional development of coordinating chemistry teachers was held during the academic year 1998-1999 at the National Center for Chemistry Teachers. Twenty-one teachers from all over the country, representing different types of high schools in Israel, participated in a weekly, full-day meeting for a total of 224 hours. Selection criteria for participation in the program were as follows:

- Teachers who currently function as coordinators or are due to become coordinators in the future
- Teacher with at least 5 years' experience as high school chemistry teachers (10th-12th grades) including experience in preparing students for matriculation examinations (final examinations set centrally by the Ministry of Education, Culture, and Sport), and who have reputations as successful teachers.
- Previous participation in at least five in-service professional activities. These are usually week-long, summer programs provided for chemistry teachers, mainly designed to introduce the teachers to the content and pedagogy of new textbooks, new curricula, or new programs.
- A recommendation provided by regional tutors or the school principal as being creative and open to curricular changes.

The Development of Content Knowledge

This part of the program was intended to update and enrich the potential coordinators with scientific chemistry content. It was based on Kempa's (1983) claim that the future development of teaching and learning materials in chemistry should include the following six dimensions: the conceptual structure of chemistry, the processes of chemistry, the technological manifestations of chemistry, chemistry as a "personally relevant" subject, the cultural aspects of chemistry, and the societal implications of chemistry. More specifically, it was suggested that, in the teaching and learning of chemistry, students should be exposed to recent investigations, namely, the frontiers of chemistry.

The Development of Pedagogical Content Knowledge

In the program, the participants were taught different instructional techniques to enhance their ability to vary the classroom-learning environment. Among the methods used were cooperative learning techniques, inquiry learning in the classroom and in the laboratory, simulations, field trips to research laboratories and various chemical industries, critical reading of scientific articles, questioning techniques, and students' miniprojects. To implement these novel methods requires management skills, flexibility, and the ability to devise an appropriate response to specific school characteristics, teaching goals, and various student populations.

The Development of Leadership Skills

In this phase of the program, the participants were also involved in programs for the development of decision-making ability, team-building and management, resolving conflicts, problem solving, and better social understanding,. Another aspect that was dealt with in the program was the need to maintain relationship with other managerial-function personnel in school, as well as with higher authorities outside school.

During the program, with the help, guidance, and support of instructors and peers, the participants were given opportunities to try in their schools the new ideas discussed in the program and, consequently, to reflect on their fieldwork, provide evidence on what was done, and obtain feedback from their peers in the program.

Instrumentation

The data on teachers' perceptions and beliefs was obtained using both quantitative and qualitative measures. These were gathered at various stages of the program and a year after its termination.

Preprogram Questionnaire. This questionnaire was administered at the beginning of the program. In the first part teachers were asked to report on the extent to which they are involved in different aspects of high school chemistry instruction. This was a Likert-type scale containing 19 items. The second part was an open-ended-type questionnaire in which the teachers were asked to report on their expectations from the program.

Midterm Questionnaire. This questionnaire was administered in the middle of the program. Its aim was to obtain the participants' opinions regarding the contributions of the program, and the pedagogical changes that the teachers had introduced thus far in their daily functioning as coordinators and as classroom teachers. The questions were open-ended.

End-of-Year Questionnaire. The first part of the questionnaire was a repetition of the preprogram questionnaire. The second part probed the teachers' perceptions regarding changes they made in their schools and in their classrooms. The open-ended questions focused primarily on whether they felt that their expectations from the program had been fulfilled.

Follow-Up Questionnaire. This questionnaire was administered to the program participants 18 months after the end of the program. The participants were asked to describe the ways in which they deal with different aspects of the coordinator's role and to reflect on the effect the various activities they experienced in the program had on their daily functioning as a coordinator and classroom chemistry teachers. All questions were open-ended.

Teachers' Tasks and Activities in Schools. Information on the teachers' activities and assignments was also gathered through report they had presented throughout the program.

Excerpted from Mangin, M.M. (2007). Facilitating elementary principals' support for instructional teacher leadership. *Education Administration Quarterly*, 43(3), 319-357.

Purpose: This exploratory study examines conditions that lead elementary principals to support the work of school-based instructional teacher leaders. The study asks, How do principals' knowledge of teacher leadership and their interaction with teacher leaders contribute to principals' support for teacher leadership? And, how might district communication structures influence principal support?

Research Methods: Data collected in 2003-2004 came from five districts, four of which were low socio-economic status districts. Interviews with 15 principals, 12 math teacher leaders, and six supervisors focused on the nature and scope of the teacher leader's work and the role of the principal and/or supervisor with regard to the teacher leader.

Findings: The study provides evidence of a link between principals' knowledge of the position, their interaction with teacher leaders, and their support for teacher leadership. The research further demonstrates that districts can influence principals' level of support for teacher leaders by increasing communication about the role.

Implications: Evidence suggests that districts should build principals' knowledge of teacher leadership and foster principal-teacher leader interaction as a way to promote support. A second implication is the need for further research on other conditions that can influence principals' support.

The study presented here responds to this gap in the literature by examining two possible conditions for support: principals' knowledge of teacher leadership roles and their interaction with teacher leaders. Principals' level of knowledge and interaction are then compared to evidence of their support, as described by principals and teacher leaders. The combination of knowledge and interaction as an indicator of support reflects a constructivist belief in the reciprocal relationship between knowledge construction and interaction with the social world (Bransford, Brown, & Cocking, 1999; Brown, Collins, & Duguid, 1989; Greeno, Collins, & Resnick, 1996; Lave & Wenger, 1991). Moreover, I examine principals' support within the social context of the district to discern ways in which communication from district supervisors influences principals' knowledge and interaction. As such, this project asks, "How do principals' knowledge of teacher leadership and their interaction with teacher leaders contribute to principals' support for teacher leadership?" And, "How might district communication structures influence principal support?" The data for this study were collected in 2003-2004 from five school districts, four of which were identified as low socio-economic status districts.

Data collection methods included interviews with 15 elementary school principals, 12 math teacher leaders, and six district-level supervisors. Findings from this exploratory study indicate a link between principals' knowledge of the position, their interaction with teacher leaders, and their support for teacher leadership. The research further demonstrates that communication from district

supervisors can influence principals' level of support for teacher leaders.

Excerpted from Moore, J.L. (1992). The role of the science co-ordinator in primary schools. A survey of headteachers' views. *School Organisation*, 12(1), 7-15.

The Teacher Leadership Project was started in the summer of 1997 with a core of 27 teachers from schools across the state. Initial participants developed a vision, mission, and model for creating technology-rich classrooms and integrating technology into curriculum. Since that time, program funding has increased and the project has expanded considerably, adding 185 teachers during the 1998-99 school year, and 215 more teachers during the 1999-2000 school year. An additional 1,000 grade K-12 teachers from public and private schools in Washington were selected to participate in the program for the 2000-2001 school year, and it is anticipated that 2,000 more teachers will be added over the next two years.

Each TLP grant recipient receives, through their district, \$9,000 worth of hardware and software, including a laptop computer, printer, and presentation device. Computers are provided at a 4:1 student to computer ratio, and recipients receive Office software, as well as Encarta Reference and Africana, Publisher, Front Page, and access to SchoolKit. Teachers are also provided with 11 days of training over the course of their first year in the program, attending a 5-day summer session, and three 2-day sessions during the school year. Training sessions are intended to help teachers (1) develop technical skills, (2) design curriculum that utilizes technology and is aligned with the state's Essential Academic Learning Requirements, and (3) identify leadership opportunities for sharing their knowledge and skills.

TLP participants are grouped geographically for training sessions, and each "regional" group typically consists of 25-30 teachers. Regional coordinators, each of whom is supported by several other trainers, as well as a technical support person, lead the sessions. Coordinators and trainers come from within the TLP, having participated in the program for at least a year prior to taking on this leadership position. Teachers bring their laptops to training sessions, enabling them to share materials and experiment with software during their time together. Training sessions, which are held in hotel conference rooms across the state, are intense and include instructional time (philosophy, research, curriculum design and alignment, software and skills, etc.), help desks (short sessions which are focused on specific technical issues), sharing, and goal setting. In addition to attending all training sessions, teachers also agree to participate in the evaluation of the project.

Each participant's school district must meet certain requirements to support their TLP teachers. Most importantly, the district must (1) agree to provide release time and classroom coverage so that teachers can attend training sessions, and (2) agree to provide technical support to maintain the equipment.

Excerpted from Oehrtman, M., Carlson, M., Vasquez, J.A. (2009) Attributes of content-focused professional learning communities that lead to meaningful reflection and collaboration among math and science teachers. Chapter in Professional Learning Communities for Science Teaching. National Science Teachers Association.

This article discusses the development and investigation of Professional Learning Communities (PLCs) in local schools in Arizona, during which investigators uncovered attributes that differentiate high-performing PLCs from lower-performing PLCs and began to uncover critical features for supporting and evaluating PLCs.

Project Pathways is a Math and Science Partnership Program at Arizona State University supported by the National Science Foundation to implement and research teacher professional development in six large urban school districts in Arizona. Teams of STEM faculty, STEM education faculty, and secondary teachers partnering to create four graduate-level courses for secondary teachers. A critical component of Project Pathways has been school-based PLCs for interdisciplinary groups of secondary mathematics and science teachers. PLC sessions engage teachers in: conceptual conversations about knowing and learning central ideas in secondary mathematics and science; discussion and assessment of student thinking; development of inquiry-based, conceptually focused lessons; and meaningful reflection on the effectiveness of their instruction.

The structure of Project Pathways offers an opportunity for high school math and science teachers to work as teams in a collaborative culture of professional development both as students in Project Pathways courses and as teachers in PLCs.

Course and PLC Norms

During each course, the instructor (a university faculty member) modeled and promoted *speaking with meaning*, a way of communicating that was negotiated as a goal during the first day of the course. In light of previous observations that revealed poor-quality discourse during the class and the PLCs, the instructor held a class discussion on “rules of engagement” that would be beneficial to improve communication and promote teacher development during the course and the PLC sessions. The notion of speaking with meaning conveyed that teachers would attempt to speak so that their words carry meaning to the listener, and are thus conceptually based; be specific by referencing quantities and avoiding the use of vague pronouns in explanations when appropriate; and explain and justify solution approaches so that the rationale for the approach can be understood by others. The rules of engagement also included such guidelines as exhibiting intellectual integrity (e.g., basing conjectures on logic, not pretending to understand when one doesn’t really understand), respecting the learning process of colleagues, and attempting to make sense of colleague’s meanings. Investigations revealed that the facilitators in cohort 1 had difficulty modeling and reinforcing these behaviors. This led to our developing facilitator workshops designed to support the facilitators in modeling speaking with meaning and promoting meaningful communication among members of a PLC.

The PLC Facilitator and PLC Sessions

Each PLC had an assigned peer leader who was charged with facilitating discussions during the PLC meetings. The facilitators were selected based on their leadership abilities as recommended by their district math/science coordinator and were initially trained during four 6-hour summer workshops. In addition to the weekly meetings, the facilitators also attended three 3-hour workshops during the semester. These workshops focused on developing specific attributes for facilitation that included their ability to ask questions to promote conceptual explanations and conversations. They were also supported in improving their facilitation ability during weekly coaching sessions with project staff. The workshop leaders engaged the PLC facilitators in a series of activities designed to improve their abilities to both listen to the quality of mathematical and scientific explanations with respect to their conceptual nature and learn to pose questions that promoted reflection on what is involved in understanding, learning, and teaching specific science and mathematics concepts. For instance, one activity included viewing and discussing 10 videos of students as they explained their thinking when responding to conceptual tasks. This activity asked the facilitators to discuss what they could infer about student understandings from the video and their rationale behind these inferences. Senior project personnel led weekly facilitator coaching sessions with the facilitators.

During each coaching session, the coach asked questions about the facilitation behaviors observed in the video of each facilitator during their previous PLC sessions to promote reflection about the quality of various PLC interactions. As the coach viewed these videos with the research team before the coaching meetings, they discussed the facilitators' effectiveness in promoting and enacting speaking with meaning about issues of knowing, learning, and teaching the content that was the focus of that PLC agenda. These discussions provided opportunities for the coach to address specific interactions during the coaching meetings that either promoted or inhibited meaningful discourse among members of a PLC.

The coach's strategies for promoting reflection about PLC interactions progressed from general discussions to making specific prompts to each PLC facilitator. During the first few coaching sessions, the coach discussed positive moves that she and the research team were noticing in hopes that the PLC facilitators who were less effective would begin to adopt the more effective strategies. As one example, she noted that when PLC members appeared to be speaking past each other, the facilitator of the PLC prompted the PLC members to put a written product on the whiteboard and encouraged the PLC members to speak about the ideas of the problem. The facilitator coach also gave general suggestions that she thought might promote positive facilitator moves, such as making an effort to listen to the meanings that the PLC members were communicating and trying to ask questions based on these meanings. As the PLC coach sensed that the facilitators were becoming more comfortable in their role as a facilitator, she became more direct with each of the PLC facilitators about behaviors that were less effective.

Methodology included administration of quantitative instruments [Views About Mathematics Survey (VAMS; Carlson, 1997) and the Views About Science Survey

(VASS; Halloun 1997; Halloun and Hestenes, 1998)] and analysis of video data and communication patterns of PLC meetings.

Excerpted from Ruby, A. (2006). Improving science achievement at high-poverty urban middle schools. *Science Education*, 90, 1005-1027.

A large percentage of U.S. students attending high-poverty urban middle schools achieve low levels of science proficiency, posing significant challenges to their success in high school science and to national and local efforts to reform science education. Through its work in Philadelphia schools, the Center for Social Organization of Schools at Johns Hopkins University developed a teacher-support model to address variation in science curricula, lack of materials, and under prepared teachers that combined with initial low levels of proficiency block improvements in science achievement. The model includes a common science curriculum based on NSF-supported materials commercially available, ongoing teacher professional development built around day-to-day lessons, and regular in class support of teachers by expert peer coaches. One cohort of students at three Philadelphia middle schools using the model was followed from the end of fourth grade through seventh grade. Their gains in science achievement and achievement levels were substantially greater than students at 3 matched control schools and the 23 district middle schools serving a similar student population. Under school-by-school comparisons, these results held for the two schools with adequate implementation. Using widely available materials and techniques, the model can be adopted and modified by school partners and districts.

In this study, the author examines whether the Talent Development model improves science achievement.

The Talent Development model provides four tiers of support: (1) an implementable curriculum, (2) ongoing intensive teacher professional development, (3) in-classroom support from peer coaches, and (4) mechanisms to foster and sustain changes in science instruction, including opportunities for science teacher cooperation and development of teacher leaders.

The TD model uses science curricula developed with the support of the National Science Foundation including the Full Option Science System (FOSS) developed by the Lawrence Hall of Science, University of California—Berkeley, and Science and Technology for Children (STC) developed by the National Science Resources Center. These science materials focus on depth of understanding of a topic rather than breadth over multiple topics. Built around hands-on activities but requiring significant amounts of student planning and analysis, these materials allow students who may be behind in not only science but also reading and math to readily take part in lessons and learn the concepts and vocabulary.

Outside the classroom professional development is provided through a multiyear sequence of monthly workshops that is grade, curriculum, and content specific for which teachers can earn graduate credit. During the first year, the workshops focus on the materials and lessons teachers will be teaching in the next month, the content knowledge behind the lessons, and the pedagogical techniques to use while teaching them. This focus on what will be taught in the next lessons distinguishes the model's professional

development from the traditional generic workshops that have failed to change teacher practices and student achievement (Killon, 1999; McLaughlin & Oberman, 1996). In later years, the focus shifts to deepening teacher content knowledge, increasing student-generated inquiries, and pedagogic challenges. At the same time, the basic professional development continues to be provided for new teachers in response to teacher mobility.

In-classroom support available on a weekly basis over the entire school year is provided by expert peer coaches familiar with the curriculum and middle grades' pedagogy. Teachers and classes vary in their abilities and needs. Peer coaches see the teachers and classes in action and help teachers adapt the professional development and materials to the specific needs of their classes using such techniques as model teaching, co-teaching, and critical observation with confidential feedback. In this way, they help the teacher customize the science reform to their class and their own needs in a way that maintains its desired impact. For example, teachers may not be comfortable with use of hands-on activities done in cooperative groups because they themselves lack the skills to manage this type of work or their students cannot successfully work together. In response, a teacher may turn to demonstrating the activities, which solves their own classroom management concerns but frustrates the purpose of using a hands-on centered curriculum. A peer coach in the classroom sees why the teacher has turned to demonstrations. They can offer the teacher specific responses to the problem, such as explicit teaching of social skills students need to work in groups, strict student roles within groups that offer the teacher more control, or better teacher preparation and time management to avoid lags during class, which will allow the use of student activities. As both teacher and students become accustomed to hands-on instruction, the peer coach can advise the teacher on reducing the structure and increasing the role of students.

In-school leadership and supporting structures are needed to maintain the sustainability of the instructional changes. Peer coaches' knowledge of the science faculty and the curriculum, and their ability to work with the school administration allows them help establish such structures as regular science faculty meetings, times for teachers to observe others' teaching, and mentoring of new teachers. These structures allow teachers to support one another, share ways to improve instruction, and help induct new teachers. Such structures built into the school schedule (versus remaining informal) are easier to maintain and receive greater support from school administration. Peer coaches are in position to identify excellent teachers who can become the trainers for new science teachers. These teachers receive additional professional development in how to train new teachers, then act as co-trainers with the coach, and finally take the lead in training workshops.

Matched Schools: The study features 3 Philadelphia schools in which the TD model was implemented, which were matched with control schools. Treatment schools 1, 2, and 3 are briefly described below.

School 1 – School 1 had the weakest implementation for the cohort studied due to an initial lack of funds to purchase materials. In the first year, the program provided supporting materials and training through classroom visits and after-school trainings. FOSS and STC science materials were purchased first with grants from the Urban

Systemic Initiative and later using school funds. These were incorporated into the curriculum first in the fifth grade and moving up through the sixth and seventh grades over time, often too late to have a major effect on the relevant cohort and teacher in-class and after-school training were provided.

School 2 – School 2 had the strongest implementation for the cohort studied. After developing a school wide science curriculum, School 2 used school funds to purchase the science materials and supplemented these with others from the Franklin Institute science Museum. Additional materials for all grades were purchased with a grant from the Urban Systemic Initiative. With the provision of monthly professional development and in-class support, implementation was strong for the next 2 years of the study, especially for the lower grades. Seventh grade suffered from extreme science teacher turnover but the continued provision of the basic level of professional development maintained a strong implementation.

School 3 – had a medium level of implementation for the studied cohort, but these students received 1 less year of exposure to the treatment as they entered the school in sixth grade. In Year 1, the science faculty developed a standard curriculum and attended after-school and in-class professional development built around the science materials purchased by the school for sixth grade. The next year saw the purchase of materials for the seventh grade and the continuation of the same level of professional development leading to strong implementation in the sixth grade and medium implementation in the seventh grade.

Excerpted from Weaver, D. & Dick, T. (2009). Oregon mathematics leadership institute project: Evaluation results on teacher content knowledge, implementation fidelity, and student achievement. *The Journal of Mathematics and Science: Collaborative Explorations*, 11, 57-84.

Abstract: The Oregon Mathematics Leadership Institute (OMLI) NSF-MSP project partners are Oregon State University, Portland State University, Teachers Development Group and ten Oregon school districts. The primary activities of the project were a sequence of three intensive three-week residential institutes emphasizing mathematics content knowledge for teaching, collegial leadership, and the building of professional learning communities. Teachers at all levels K-12 participated together in the mathematics content courses. By the conclusion of the third summer institute, teachers had shown significant improvements in mathematical content knowledge for teaching. Analysis of student achievement data in participating schools was initially inconclusive. However, once implementation fidelity traits were taken into account, a positive relationship between project participation and student achievement emerged. The degree to which schools implemented the practices promoted by the OMLI project is a significant positive predictor of student performance above and beyond what can be explained by the socioeconomic factor as indicated by the percent of students who qualify for free and reduced lunch program. This relationship is particularly acute at secondary levels, but additional factors appear to be at play at elementary grade levels.

Setting: OMLI is a partnership between Oregon State University, Portland State University, Teachers Development Group, and 10 Oregon school districts: Beaverton, Bend-LaPine, Crook County, Molalla River, North Clackamas, Redmond, Reynolds, Roseburg, South Lane, and Woodburn. These school districts include both rural and urban settings, a wide range of socio-economic student backgrounds, and one district with a majority of ELL students.

Intervention: The unit of participation in OMLI is a School Leadership Team, ideally consisting of two teachers and one school administrator, usually the principal of the school...Participating teachers attended 3-week residential summer institutes in three consecutive summers (2005, 2006, and 2007). The participating administrators attended the third week of each of the three summer institutes. These summer institutes included mathematics content coursework across six strands: numbers and operations, algebraic structures, measure and change, geometry, data analysis and probability, and discrete mathematics. The mathematics content coursework was complemented by leadership development coursework. Academic year activities facilitate the ongoing development of collaborative professional learning communities within each participating school. These activities will continue at least through the 2008-2009 academic year and are intended to promote and sustain systemic mathematics reform to increase student achievement in mathematics...

The typical schedule for the institute involved teachers attending two two-hour mathematics classes in the morning with a two-hour study session and a two-hour Collegial Leadership workshop in the afternoon. Approximately 60 teachers each were

enrolled in a “triad” of courses consisting of a pair of mathematics courses and the Collegial Leadership workshop. Hence, all 180 would have participated in all six mathematics content strands and three Collegial Leadership workshops by the conclusion of the third summer institute in summer 2007. The six mathematics content strands are paired as follows: 1) Numbers and Operations & Geometry; 2) Data and Chance & Discrete Mathematics; 3) Algebraic Structures & Measurement and Change.

Using the Conferences Board of the Mathematical Sciences recommendations for the preparation of teachers, OMLI mathematics instructors chose depth in a few “big idea” topics rather than attempting to address many topics. In each content course there was an explicit emphasis on student discourse and faculty were expected to model many of the pedagogical techniques used in K-12 classrooms that are the focus of the Collegial Leadership workshops in the afternoons.

During one of the afternoon periods, teachers participate in a facilitated “study hall” with mathematics content faculty available for assistance. During the other period, teachers participated in a Collegial Leadership workshop facilitated by staff from the Teachers Development Group....During the afternoons of the third week, principals had opportunities to work together in a team with the teachers from their schools to develop school action plans for professional development during the upcoming year.

During CLM activities, the Collegial Leadership team draws heavily on the latest nationally-recognized, evidence-based mathematics professional development and leadership development resources, such as: *Designing Professional Development for Teachers of Science and Mathematics*, *Video Cases for Mathematics Professional Development, 6-10*, *Learning to Lead Mathematics Professional Development*, *Fostering Algebraic Thinking: A Guide for Teachers, Grades 6-10*, *Developing Mathematical Ideas*, *Children’s Mathematics: Cognitively Guided Instruction*, and *Lenses on Learning*. Team members modeled and emphasized NCTM Standards-based “best” instructional practices and curricula and provide extensive instruction and mentoring to School Leadership Teams for effective job-embedded, practice-based professional learning (e.g., lesson study, protocol-based collegial observations and examinations of student work, case discussions and development, book studies, etc.).

Site visits to participating OMLI schools involved a minimum of a half-day site visit per school, with four site visits each year per school. These site visits are designed to:

1. Support School Leadership Teams for implementation of their Collegial Leadership Action plans, which were crafted by the teams during the 2007 Summer Institute to initiate and sustain school-based collaborative professional learning communities whose work centers on mathematics content, learning, teaching, and leadership.
2. Support continued learning by the OMLI participants and their school colleagues through first-hand experiences with practice-based professional learning facilitated by OMLI faculty. Specific site visit activities designed to support learning for effective lesson design and implementation:

- Data snaps (classroom walk-throughs) to gather data as context for professional dialogue and making inferences regarding what typifies mathematical discourse across the school
- Case discussions (video and print)
- Extended classroom observations and inference dialogue based on Teachers Development Group's Student Discourse Observation Protocol and Collaborative Lesson Planning (designed to support teachers in moving classroom discourse along a continuum from a focus on procedures and facts to a focus on justification and generalization)
- Consultation regarding implementation of school mathematics curriculum materials
- Co-facilitation (with OMLI participants) of school-based professional development and district [sic]
- Coaching OMLI participants in leading the district site visit meetings
- Facilitating and/or coaching the facilitation of the examination of student work by OMLI participants and/or their building colleagues

In addition to site visits, OMLI site visit faculty members facilitate four half-day district meetings throughout the academic year in each district. During these meetings all participating OMLI teachers and administrators from a district come together to share their successes and challenges, plan for district-wide expansion of OMLI, and to continue learning together by examining student work, discussing professional readings, collaborative lesson planning, analyzing and enhancing mathematical tasks, and/or other activities such as those in the bulleted list above....

School Leadership Teams were expected to actively increase the quantity and quality of school-based collegial inquiry and discourse about mathematical and pedagogical content by planning and facilitating regular academic year meetings of building colleagues, using and facilitating practice-based professional development activities such as classroom observations and collaborative examinations of student work.

Research Questions:

1. Has the OMLI professional development prepared the teacher leaders for their leadership role in terms of mathematics content knowledge for teaching?
2. Has the OMLI project increased student achievement (as indicated by the percentage of students who demonstrate proficiency on the Oregon State Mathematics Assessment for grades 3, 5, 8, and 10) in all participating K-12 schools?

Implementation scales – RMC Research analyzed data from the 13-trait rubric and identified 2 sets of 5 of the 13 traits that were highly correlated to student achievement on the 2007 state assessment. One set was correlated to student achievement at the elementary level and the other set was correlated to student achievement at the secondary level.

Secondary Implementation Scale – Grades 8 & 10: The following traits made up the secondary implementation scale (SIS) and are correlated to student achievement in secondary schools. RMC Research used the ratings for each school (on the 13-trait rubric they developed) to calculate the elementary and secondary implementation scale score for each OMLI school.

- Quality of the school action plan for improving mathematics teaching and learning developed by the school leadership team during the summer institutes;
- How well the school leadership team implemented the action plan;
- The degree to which the school leadership team conducted regular school-based professional development with the other mathematics teachers in their school;
- The degree to which the school-based professional development reached all or a critical mass of mathematics teachers in the school; and
- The degree to which the professional development utilized well-defined professional learning tasks and protocols developed by project staff and modeled during summer institutes

Elementary Implementation Scale – Grades 3 & 5: The following traits make up the elementary implementation scale (EIS) and were correlated to student achievement in elementary schools (Grades 3 and 5):

- Leadership qualities of the teachers on the school leadership team;
- Whether the school leadership team had a second teacher participating;
- The degree to which the school and district policies and practices are supportive of the work of the school leadership team;
- The degree to which mathematics is a priority for the school; and
- The degree to which the professional development utilized well-defined professional learning tasks and protocols developed by project staff and modeled during the summer institutes