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Effective Professional Development: Defining the Vital Role of the Master Teacher

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Originally conceptualized in 1987 as a bridge between research mathematicians at Rice University and the precollege mathematics education community, the Rice University School Mathematics Project (RUSMP) has evolved over time, transcending its initial goal, and now serving as a nationally recognized K-12 mathematics education center with a documented ability to improve teacher knowledge and student learning (e.g., Cruz, Turner, & Papakonstantinou, 200; Killion, 2002a, 2002b, 2002c; McCoy, Hill, Sack, Papakonstantinou, & Parr, 2007; Parr, Papakonstantinou, Schweingruber, & Cruz, 2004; Troutman, 2011). RUSMP nurtures and prepares mathematics teachers to become a collaborative community of highly-skilled, K-12 mathematics educators capable of providing effective mathematics instruction to all students regardless of race, gender, socioeconomic status, mathematics aptitude, or prior success in mathematics.

RUSMP's mission is to help teachers and school administrators better understand the nature of mathematics and to provide effective teaching and assessment of mathematics, equipping all students for success as they encounter mathematics in today's society. To achieve this mission, RUSMP is based upon the principle that teachers learn best from fellow teachers, identified as master teachers, who are knowledgeable and experienced. Although RUSMP offers a wide variety of programs and support for the K-12 educational community, the cornerstone of RUSMP is its Summer Campus Program (SCP) initiated through National Science Foundation (NSF) funding (TEI 86-52030 and TEI 9055501). This paper discusses the selection, development, characteristics, roles, and impact of teacher leaders identified by RUSMP as SCP master teachers.

A key to the success of SCP are master teachers, who are K-12 classroom teachers serving as instructors, role models, and mentors for participants in the program. Initially developed in 1987 as a six-week course with a primary focus on developing the content knowledge of 48 middle and high school mathematics teachers, SCP is now a four-week program that serves 80-120 K-12 teachers annually in classes separated into grade bands who participate in a rigorous program that explores all aspects of contemporary mathematics education including mathematics content, instruction, assessment, and issues related to access and equity in the classroom. These grade bands include elementary (K-3), intermediate (4-6), middle (7-8), and high (9-12).

Selection and Development of the RUSMP Master Teacher

In our SCP program, master teachers have always been selected for their abilities as exemplary teachers as identified by Rice University faculty and local district mathematics leaders. During the first three years of SCP, master teachers worked closely with Rice University faculty from the mathematics, mathematics sciences, statistics, and computer science departments to prepare lessons on advanced mathematics topics such as linear algebra, number theory, mathematical induction, and mathematical modeling. It was expected that master teachers would develop a better understanding of advanced mathematics through their interactions with Rice University faculty as they prepared these lessons (Capper, 1987). As school district needs changed, so did SCP. Today, SCP targets teachers identified as most benefiting from intensive long-term professional development in mathematics content and pedagogy, including induction year teachers and teachers who are new to teaching mathematics. Over the years, as the focus of the mathematics content shifted from exploring advanced mathematics to developing a deep understanding of the precollege mathematics that K-12 teachers are expected to teach, the paradigm for selecting and developing master teachers changed. In recent years, SCP focuses on pedagogy as well as precollege mathematics. Rice University faculty no longer selects master teachers; the faculty serves as a resource for current master teachers and makes presentations for SCP participants. New master teachers are now selected by RUSMP directors with recommendations from current master teachers through a process that includes observations of candidates as they interact with both students and with other teachers.

Presently, new master teachers are mentored by current master teachers and RUSMP directors with assistance from the Rice University mathematics faculty rather than solely by Rice University mathematics faculty, as today's master teachers are charged with many more tasks than in the early years. These include helping novice teachers with classroom management and discipline, modeling differentiated instruction and assessment techniques, demonstrating how to organize classrooms for student-centered instruction, leading book studies, and incorporating more technology into instruction (e.g., interactive white boards, web sites).

Characteristics of a RUSMP Master Teacher

The founding directors of RUSMP described RUSMP master teachers as precollege teachers who were "recognized by their peers or administrators in either a formal or informal way as being among the best in the teaching profession, and whose practices it would be good, in principle, for other teachers to emulate" (Austin, Herbert, & Wells, 1990). Killion (2011) defines teacher leaders as:

> …teachers who have both more experience and a level of expertise as a professional educator not typical in novice teachers. This perspective of teacher leadership acknowledges that one grows into a leadership role through a wide range of experiences and formal and informal professional development. (p. 7)

One of the founding directors of RUSMP, the current director of RUSMP (one of the first RUSMP master teachers), and former and current RUSMP master teachers completed questionnaires and participated in focus group discussions designed to create a profile of the characteristics of master teachers. The characteristics that emerged mirror the combined perspectives of Austin, Herbert, and Wells (1990) and Killion (2011). RUSMP master teachers today are expected to do the following:

- act as role models whose practices would be good for other teachers to emulate;
- utilize interpersonal skills to connect with teacher participants;
- motivate teacher participants to learn content and pedagogical skills;
- develop curriculum for SCP;
- share their passion and enthusiasm with others about the content being taught;
- demonstrate through presentations, publications, and lesson modeling;
- facilitate professional learning opportunities; and
- realize the importance of their professional growth.

In addition, RUSMP master teachers acknowledge that they have grown into their leadership roles and are recognized by their peers and administrators as reflective leaders who are among the best in the profession, with knowledge and skills to affect change. The RUSMP master teachers come together regularly as a professional learning community to discuss issues related to pedagogy and policy and to further their own personal professional development. They also participate in RUSMP professional development sessions (e.g., book studies, technology implementation, assessment techniques). In addition, master teachers continue to grow further through their participation in professional organizations and by attending and presenting at conferences.

Tasks of the SCP Master Teacher

Using the information from the questionnaires and focus group discussions, a job analysis for the position of SCP master teacher was conducted. Three broad task categories emerged as being fundamental to the job of a master teacher:

- developing curriculum materials and resources for SCP;
- determining individual characteristics and abilities of participants; and
- presenting lessons incorporating both mathematical content and recommended pedagogical practices.

Each of these roles is discussed further, below.

Developing curriculum materials and resources for SCP.

> When you teach the right things the right way, motivation takes care of itself. If students aren't enjoying learning, something is wrong with your curriculum and instruction – you have somehow turned an inherently enjoyable activity into drudgery. (Brophy, 1998, p. 1)

Master teachers motivate participants to learn through developing curriculum materials that include academic activities that are engaging, meaningful, and worthwhile. Master teachers possess considerable knowledge of current practices in education including the National Council of Teachers of Mathematics' (NCTM) mathematical content standards of number and operations, algebra, geometry, measurement, and data analysis and probability and the process standards of problem solving, reasoning and proof, communication, representation, and connections (NCTM, 2000). These mathematical content and process standards have had longstanding importance in K-12 mathematics education. These same NCTM standards as well as the strands of mathematical proficiency specified in the National Research Council's (NRC) report *Adding It Up* (NRC, 2001) are embedded in the Standards for Mathematical Practice described in the Common Core State Standards (Common Core State Standards Initiative, 2011). As curriculum specialists, master teachers utilize their wealth of knowledge of the mathematical processes and proficiencies within the standards of NCTM and the Common Core to develop the participants' essential understandings of mathematical content and pedagogical skills.

Creativity is required, as master teachers incorporate a variety of everyday materials that connect the real world and mathematics, such as newspapers, menus, cereal boxes, cans, tennis balls, hula hoops, string, coffee filters, and measuring spoons. Master teachers strive to empower teachers with an increased understanding of mathematics by promoting the investigation of mathematical concepts in the real world and by linking the mathematics learned in the classroom to mathematics encountered outside the classroom (Troutman, 2011).

Master teachers select appropriate resources for their classes that can be used to illustrate the mathematical concept being explored. This requires considerable knowledge of the various classroom manipulatives that are available, as well as knowledge of how the manipulatives can be most effectively incorporated into the lesson. During lesson preparation, careful consideration is given to the effective use and integration of technology such as calculators, computers, interactive white boards, tablets, online environments to support collaboration and course management, and web-based instruction in the classroom. Lesson preparation also includes incorporating age-appropriate children's literature, field trips, guest speakers, articles, journals, and resource books.

Further, master teachers possess ample organizational and planning skills and the ability to work collaboratively with others. As there are two master teachers in each class with RUSMP directors serving as advisors in planning the instructional process, master teachers never work in isolation; instead they are able to capitalize on the strengths of other professionals and university professors. The importance of this collaboration cannot be emphasized enough, whether it is among master teachers or teachers, as it promotes professional growth. The National Council of Supervisors of Mathematics (NCSM) has identified the theme of teacher collaboration and professional learning as essential when contemplating the specific domains of leadership focus and responsibility (NCSM, 2012).

Determining Individual Characteristics and Abilities of Participants. Another major category of tasks of master teachers focuses on gauging the initial ability levels of participants and how best to assist them in the learning process. Master teachers move about the classroom listening to group discussions and providing input as requested to clarify questions the participants may have. Consequently, well-developed observational and effective listening skills are essential, allowing master teachers to assist participants who are having difficulty, particularly in a group setting. This process occurs even if participants are unaware that they do not fully understand the concept or are unwilling to acknowledge that they have lack of understanding. As master teachers interact with participants one-on-one as well as in group settings, they gauge their participants' individual comfort level with the material and utilize a certain level of sociability and interpersonal skills to effectively listen to participants and respond with sensitivity to their needs. In addition, master teachers use pre- and post-surveys as well as participants' reflections in daily journals to gauge participants' ability levels and growth.

Fundamental gauges of participants' ability levels are assessments that provide information on teachers' mathematics and pedagogical knowledge (see Appendix for sample assessment items). Master teachers create these assessments and administer them to participants at both the beginning and the end of SCP to assess knowledge and pedagogical growth. A certain degree of creativity in developing unique and thought-provoking mathematical content questions, along with strong pedagogical content knowledge, is required to develop meaningful assessments.

Formative assessments are utilized as a vehicle for master teachers to provide ongoing feedback to participants through their daily journals. Technology is incorporated as participants enter these journal writings into a class management system. Participants become accustomed to this personalized feedback of providing suggestions and pedagogical tips to enhance their specific instructional practices and needs.

Presenting Lessons Incorporating Both Mathematical Content Information and Recommended Pedagogical Practices. The final, and most crucial, aspect of the master teacher's job is the presentation of lessons encompassing both the mathematical content and the pedagogical skills needed to effectively convey that knowledge. Therefore, master teachers must be able to speak accurately and fluently about complex topics before a class of teachers and be able to interact comfortably with a second instructor. In addition, master teachers must possess an extensive knowledge of mathematics content in the grade level they are addressing and beyond that grade level, including an understanding of nationally accepted standards for teaching that mathematics content.

Technology and manipulatives are used to better illustrate the concepts being explored in SCP. The seamless integration of technology and manipulatives into instruction demands that master teachers have knowledge of multimedia technology, social networking, instructional apps, interactive white boards, tablets, educational software, graphing calculators, data collection devices, and internet sites, as well as knowledge of the capabilities and limitations of such technology.

Master Teachers as Role Models

One significant overarching role of master teachers is their responsibility for serving as role models for other teachers. Throughout SCP, master teachers provide participants in the program with implicit examples of developing and teaching lessons, involving students in discussions, and working with other educators in the planning and implementation of effective lessons. These opportunities help participants develop an understanding of pedagogical content knowledge that might be used by participants to successfully engage students.

Over time, master teachers have recognized that role modeling builds the self–efficacy of participants. Self-efficacy has been found to have a direct positive relationship with performance (Bandura, 1997; Bandura & Locke, 2003; Tschannen-Moran & McMaster, 2009), and higher self-efficacy can lead to setting more challenging goals (Bandura, 1997; Williams, T. & Williams, 2010), which are associated with higher performance (Locke & Latham, 1990). Social psychology has found that role modeling can enhance a person's self-efficacy, or confidence in one's own abilities (Bandura, 1986, 1997).

SCP participants, by observing master teachers, can develop a thorough understanding of the complexity of the tasks these master teachers are performing, and they can detect how to best manage aspects of the tasks that might arise in unexpected situations (Gist & Mitchell, 1992; Moberg, 2000). These observations help instill within participants the idea that if the master teachers can do it, they can, too.

Recent Results

Evidence from the 2010 and 2011 years of RUSMP's SCP indicates that its master teacher methodology does indeed improve participants' self-efficacy. Each year, participants are administered questionnaires at both the beginning and at the end of their experience with SCP. Questions address their beliefs about teaching and learning mathematics, their evaluation of the program itself, and their feelings of preparedness in the following seven instructional areas:

- Presenting the applications of mathematical concepts
- Using cooperative learning groups
- Considering students' prior conceptions about mathematics when planning curriculum and instruction
- Using hands-on activities to introduce and develop math concepts
- Managing a class of students who are using manipulatives
- Using technology as an integral part of math instruction
- Using a variety of methods to assess students' mathematical knowledge

Pretest and posttest survey data were collected from all 84 participants in the 2010 SCP and 76 of the 80 participants in the 2011 SCP and results indicate that participants felt more confident in their ability to teach mathematics following their completion of the program.

Upon completion of the program, most participants reported feeling fairly well prepared or very well prepared in presenting the applications of mathematical concepts (97.6% in 2010 and 94.8% in 2011 as shown in Table 1), using cooperative learning groups (98.8% in 2010 and 97.4% in 2011 as shown in Table 2), taking into account students' prior conceptions about mathematics when planning curriculum and instruction (95.2% in 2010 and 98.6% in 2011 as shown in Table 3), using hands-on activities to introduce and develop math concepts (100% in 2010 and 100% in 2011 as shown in Table 4), managing a class of students who are using manipulatives (100% in 2010 and 100% in 2011 as shown in Table 5), using technology as an integral part of math instruction (90.4% in 2010 and 96.1% in 2011 as shown in Table 6), and using a variety of methods to assess students' mathematical knowledge (97.7% in 2010 and 98.6% in 2011 as shown in Table 7).

Paired samples t-tests performed on aggregated data for all classes indicated that participants' sense of preparedness had increased significantly ($p < .05$) in all instructional areas except for using a variety of methods to assess students' mathematical knowledge over the course of the program in 2010. Disaggregated data revealed very similar results for the participants in the elementary and intermediate classes focused on grade level bands, K-3 and 4-6, respectively. Participants in the middle and high school grade level classes also showed gains in their sense of preparedness in the same six instructional areas. However, participants in these upper grade level classes showed gains that were statistically significant for three or four of the instructional areas.

In 2011, paired samples t-tests performed on aggregated data for all grade level bands of participants indicated that their sense of preparedness in all of the seven instructional areas had increased significantly ($p < .001$) over the course of the program. Comparable results were apparent for all or for six of the seven instructional areas for all grade level bands in 2011 ($p < .05$). Means and standard deviations of these ratings are presented in Table 8 for the 2010 SCP and in Table 9 for the 2011 SCP.

Table 1: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to present the applications of mathematical concepts?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	2	2.4	4	5.3
Fairly well prepared	23	27.4	17	22.4
Very well prepared	59	70.2	55	72.4
Total	**84**	**100.0**	**76**	**100.0**

Table 2: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to use cooperative learning groups?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	1	1.2	2	2.6
Fairly well prepared	23	27.4	17	22.4
Very well prepared	60	71.4	57	75.0
Total	**84**	**100.0**	**76**	**100.0**

Table 3: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to consider students' prior conceptions about mathematics when planning curriculum and instruction?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	4	4.8	1	1.3
Fairly well prepared	19	22.6	22	28.9
Very well prepared	61	72.6	53	69.7
Total	**84**	**100.0**	**76**	**100.0**

Table 4: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to use hands-on activities to introduce and develop math concepts?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	0	0	0	0
Fairly well prepared	12	14.5	14	18.4
Very well prepared	71	85.5	62	81.6
Total	**83**	**100.0**	**76**	**100.0**

Table 5: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to manage a class of students who are using manipulatives?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	0	0	0	0
Fairly well prepared	21	25.0	20	26.3
Very well prepared	63	75.0	56	73.7
Total	**84**	**100.0**	**76**	**100.0**

Table 6: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to use technology as an integral part of math instruction?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	8	9.6	3	3.9
Fairly well prepared	40	48.2	31	40.8
Very well prepared	35	42.2	42	55.3
Total	**83**	**100.0**	**76**	**100.0**

Table 7: Results for RUSMP SCP 2010 and 2011 participants' post-program self-ratings on "After your experience, how well prepared do you feel you are to use a variety of methods to assess students' mathematical knowledge?"

	Results from RUSMP SCP 2010		**Results from RUSMP SCP 2011**	
	Frequency	Percent	Frequency	Percent
Not well prepared	0	0	0	0
Somewhat prepared	2	2.4	1	1.3
Fairly well prepared	25	29.8	22	28.9
Very well prepared	57	67.9	53	69.7
Total	**83**	**100.0**	**76**	**100.0**

Table 8: Paired t-test results for RUSMP SCP 2010 participants' pre- and post-program self-ratings of preparedness for instruction in each category

	All Classes N=84		Elementary (K-3) N=19		Intermediate (4-6) N=23		Middle School (7-8) N=21		High School (9-12) N=21	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Present the applications of mathematical concepts	3.23 (.73)	3.68 (.52)	3.26 (.65)	3.84 (.38)	3.22 (.85)	3.83 (.39)	3.10 (.77)	3.43 (.60)	3.33 (.66)	3.62 (.59)
	$t(83) = -4.69, p = .000$		$t(18) = -3.64, p = .002$		$t(22) = -3.48, p = .002$		$t(20) = -1.44, p = .167$		$t(20) = -1.45, p = .162$	
Use cooperative learning groups	3.15 (.81)	3.70 (.49)	3.32 (.58)	3.95 (.23)	3.04 (1.00)	3.78 (.42)	3.19 (.81)	3.48 (.51)	3.10 (.77)	3.62 (.59)
	$t(83) = -6.42, p = .000$		$t(18) = -4.61, p = .000$		$t(22) = -4.10, p = .000$		$t(20) = -2.03, p = .055$		$t(20) = -2.59, p = .018$	
Consider students' prior conceptions about mathematics when planning curriculum and instruction	3.01 (.74)	3.68 (.56)	3.37 (.60)	3.95 (.23)	3.04 (.83)	3.74 (.54)	2.86 (.57)	3.38 (.67)	2.81 (.81)	3.67 (.58)
	$t(83) = -8.52, p \leq .000$		$t(18) = -4.16, p = .001$		$t(22) = -5.25, p = .000$		$t(20) = -2.95, p = .008$		$t(20) = -4.95, p = .000$	
Use hands-on activities to introduce and develop math concepts	3.04 (.84)	3.85 (.36)	3.37 (.69)	4.00 (0)	3.13 (.82)	3.91 (.29)	2.86 (.86)	3.76 (.44)	2.79 (.92)	3.74 (.45)
	$t(81) = -9.04, p = .000$		$t(18) = -4.03, p = .001$		$t(22) = -4.41, p = .000$		$t(20) = -4.66, p = .000$		$t(20) = -4.87, p = .000$	
Manage a class of students who are using manipulatives	3.23 (.78)	3.75 (.44)	3.63 (.50)	4.00 (0)	3.26 (.69)	3.74 (.45)	3.14 (.85)	3.62 (.50)	2.90 (.89)	3.67 (.48)
	$t(83) = -6.67, p = .000$		$t(18) = -3.24, p = .005$		$t(22) = -3.45, p = .002$		$t(20) = -2.91, p = .009$		$t(20) = -3.93, p = .001$	
Use technology as an integral part of math instruction	3.05 (.87)	3.32 (.65)	3.00 (.91)	3.44 (.71)	3.04 (.77)	3.43 (.66)	3.00 (.78)	3.05 (.59)	3.15 (1.09)	3.35 (.59)
	$t(81) = -2.65, p = .010$		$t(17) = -1.92, p = .072$		$t(22) = -2.40, p = .025$		$t(20) = -.326, p = .748$		$t(19) = -.748, p = .464$	
Use a variety of methods to assess students' mathematical knowledge	3.99 (.11)	3.65 (.53)	4.00 (0)	4.00 (0)	4.00 (0)	3.61 (.50)	4.00 (0)	3.43 (.51)	3.95 (.22)	3.62 (.67)
	$t(83) = 5.85, p = .001$				$t(22) = 3.76, p = .001$		$t(20) = 5.16, p = .000$		$t(20) = 2.32, p = .031$	

Note: Standard deviations in parentheses; Mean on a 4-point scale (Anchored with 1 = not well prepared and 4 = very well prepared).

Table 9: Paired t-test results for RUSMP SCP 2011 participants' pre- and post-program self-ratings of preparedness for instruction in each category

	All Classes N=76		Elementary (K-3) N=18		Intermediate (4-6) N=19		Middle School (7-8) N=19		High School (9-12) N=20	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Present the applications of mathematical concepts	3.04 (.70)	3.67 (.58)	2.94 (.64)	3.78 (.43)	2.84 (.83)	3.79 (.54)	3.11 (.66)	3.53 (.61)	3.25 (.64)	3.60 (.68)
	t(75) = -6.07, *p* = .000		*t*(17) = -5.72, p = .000		*t*(18) = -3.51, p = .003		*t*(18) = -2.65, p = .016		*t*(19) = -1.68, p = . 110	
Use cooperative learning groups	3.13 (.62)	3.72 (.51)	3.11 (.68)	3.94 (.24)	3.21 (.54)	3.68 (.48)	3.05 (.78)	3.68 (.58)	3.15 (.49)	3.60 (.60)
	t(75) = -7.41, *p* = .000		*t*(17) = -5.72, *p* = .000		*t*(18) = -2.96, *p* = .008		t(18) = -3.31, *p* = .004		t(19) = -3.33, *p* = .004	
Consider students' prior conceptions about mathematics when planning curriculum and instruction	2.96 (.74)	3.68 (.50)	3.06 (.73)	3.83 (.38)	2.79 (.86)	3.74 (.45)	3.05 (.71)	3.63 (.50)	2.95 (.69)	3.55 (.61)
	t(75) = -7.79, *p* = .000		*t*(17) = -5.10, *p* = .000		*t*(18) = -4.53, *p* = .000		*t*(18) = -3.28, *p* = .004		*t*(19) = -3.04, *p* = .007	
Use hands-on activities to introduce and develop math concepts	2.99 (.83)	3.82 (.39)	3.39 (.70)	4.00 (00)	2.79 (.86)	3.74 (45)	3.00 (.94)	3.74 (.45)	2.80 (.70)	3.80 (.41)
	t(75) = -8.31, *p* = .000		*t*(17) = -3.72, *p* = .002		*t*(18) = -4.26, *p* = .000		*t*(18) = -3.24, *p* = .005		*t*(19) = -5.63, *p* = .000	
Manage a class of students who are using manipulatives	3.18 (.76)	3.74 (.44)	3.44 (.62)	3.72 (.46)	2.89 (.88)	3.79 (.42)	3.32 (.67)	3.68 (.48)	3.10 (.79)	3.75 (.44)
	t(75) = -6.10, *p* = .000		*t*(17) = -2.05, *p* = .056		*t*(18) = -4.46, *p* = .000		*t*(18) = -2.11, *p* = .049		*t*(19) = -3.58, *p* = .002	
Use technology as an integral part of math instruction	2.89 (.87)	3.51 (.58)	3.00 (.84)	3.83 (.38)	2.58 (1.02)	3.42 (.61)	2.89 (.81)	3.16 (.60)	3.10 (.79)	3.65 (.49)
	t(75) = -5.93, *p* = .000		*t*(17) = -4.12, *p* = .001		*t*(18) = -3.44, *p* = .003		*t*(18) = -1.76, *p* = .096		*t*(19) = -2.60, *p* = .017	
Use a variety of methods to assess students' mathematical knowledge	2.86 (.71)	3.68 (.50)	2.83 (.71)	3.72 (.46)	2.68 (.89)	3.63 (.50)	2.95 (.71)	3.74 (.56)	2.95 (.51)	3.65 (.49)
	t(75) = -9.80, *p* = .000		*t*(17) = -6.47, *p* = .000		*t*(18) = -4.26, *p* = .000		*t*(18) = -4.83, *p* = .000		*t*(19) = -4.77, *p* = .000	

Note: Standard deviations in parentheses; Mean on a 4-point scale (Anchored with 1 = not well prepared and 4 = very well prepared).

Conclusion

> The most promising forms of professional development engage teachers in the pursuit of genuine questions, problems, and curiosities, over time, in ways that leave a mark on perspectives, policy, and practice. They communicate a view of teachers not only as classroom experts, but also as productive and responsible members of a broader professional community. (Little, 1993, p. 131)

The professional development provided by RUSMP master teachers is more than just short-term, traditional, instructor-focused mathematical content delivery. Through the leadership and role modeling exhibited by RUSMP master teachers, participants gain content knowledge and develop informally as teacher leaders. RUSMP master teachers are more than mentors; they serve as sources of information and as collegial peers who help guide their fellow teachers.

Overwhelmingly positive changes in participants' self-ratings of their preparedness and self-efficacy for mathematics instruction demonstrated powerful consequences for participants involved in these leadership and role modeling relationships. At the conclusion of the program, participants in all classes reported greater levels of preparedness to present applications for mathematical concepts, use cooperative learning groups, consider students' prior conceptions about mathematics when planning curriculum and instruction, use hands-on activities to introduce and develop math concepts, manage a class of students who are using manipulatives, and use technology as an integral part of math instruction.

In the current climate of high-stakes testing, student assessment, in particular, is a highly charged topic. Mindful of the associated responsibilities and pressures often experienced by teachers, master teachers exposed participants to innovative and emerging techniques of formative and summative assessments, strategies for implementing them, as well as practical ways for utilizing assessment results to improve teaching and learning. However, the only instructional area in which participants' mean self-rating of preparedness did not improve was on their use of a variety of methods to assess students' mathematical knowledge. It is highly possible that RUSMP's comprehensive and integrated approach to student assessment may have provided participants with a quite different frame of reference between the pre- and post-program survey administration regarding this area of instruction. Therefore, it is likely that evidence of the program's effectiveness in the particular instructional area may have been masked by response shift bias (Howard, 1980).

Participants also have achieved high levels of self-efficacy through the leadership and role modeling provided by the RUSMP master teachers. Peer relationships can provide an individual with information about career strategies, performance feedback, and friendship and emotional support beyond what a traditional, hierarchical, mentor/mentee relationship can offer (Kram & Isabella, 1985; Parker, Hall, & Kram, 2008). Clearly, both participants and their schools can benefit from such a professional development paradigm.

This paper investigated the selection, development, characteristics, roles, and impact of teacher leaders identified by RUSMP as SCP master teachers. The roles of the master teachers have evolved over time as SCP has evolved to include a wide variety of educational leadership positions such as curriculum specialists, mentors, role models, motivators, resource providers, and experts in the field of mathematics. These roles are vital to effective teacher professional development.

Appendix

Sample Assessment Items

1. How does learning mathematics from a measurement perspective influence a child's understanding of numeric relationships? Give an example of a measurement activity for your grade level to justify your response.

2. The diagonals in a quadrilateral are perpendicular to each other and bisect the vertex angles of the quadrilateral. Circle all of the figures below that always have these properties.

I Rectangle

II Square

III Rhombus

IV Parallelogram

V Kite

VI Isosceles Trapezoid

3. SAT math scores are scaled so that they are approximately normal, with the mean about 511 and the standard deviation about 112. A college wants to send letters to students scoring in the top 20% on the exam. What SAT math score should the college use as the dividing line between those who get letters and those who do not?

4. Select an algebraic concept, and then describe how you could use manipulatives AND computer technology to teach this concept. Then explain the geometric connection shown by using one or the other. Give an example of one such algebra problem, and draw a graphic representation.

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