Session Number: **4**

Abstract Name: **Sustained, Content-Based PD: Knowledge Generated from the PennSTI**

MSP Project: University of Pennsylvania Science Teacher Institute
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1. Questions(s) or issue(s) for dialogue at Learning Network Conference session:

What professional development strategies are successful in narrowing student achievement gaps due to gender and/or race/ethnicity?

How do we ensure that positive changes for students and/or teachers are sustained after the period of funding?

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2. Context of the work within the STEM education literature and within your MSP project:

Recent policy documents focused on science and mathematics education reform have proposed that content-based professional development for teachers improves student achievement (National Academy of Science, 2005; National Science Foundation, 2007). The teachers involved in PennSTI project completed a Master's degree in science that is comprised of eight science courses and two science education courses over three, consecutive summer sessions and throughout two academic years. The project's science courses focus on developing teachers' science (MISEP) or chemistry (MCEP) content knowledge, while the education courses are designed to encourage teachers to integrate new instructional and assessment strategies into their science teaching. To date, about forty teachers, enrolled as two cohorts (A & B), have completed the STI project.

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3. Claims examined in the work:

A. Intensive, sustained professional development changes teaching strategies (Tables 1 and 2), enhances teacher content knowledge (Table 3), and improves student achievement (Table 4).
B. Increased use of inquiry (standards-based instruction) enhances student achievement (Table 5).
C. Increased teacher content knowledge increased student achievement (Table 5).
D. Demographic characteristics (gender and/or race/ethnicity) affect student achievement (Table 5).
E. Understanding the nature of science improves student achievement (Table 5).

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4. Evaluation and/or research design, data collection and analysis:

Both middle school science (MISEP) and high school chemistry (MCEP) teachers and their students responded to questionnaires concerning teaching and learning practices before a teacher's participation (Pre), one year after beginning of the project (Post Year 1), two years after beginning of the project(Post Year 2), and after completion of the STI project (Final). In addition, teachers took content tests before their first institute and after completing the project. For each teacher, students in one class took an achievement test each year. The teacher questionnaire included subscales focused on teaching practices, student learning activities, principal and parent support for science education, and understanding of the nature of science. The student questionnaire contains subscales on teaching practices, student learning activities, parent/adult support of science studies, friends' interest in science, and student views of science. All items were answered using Likert-type scales that indicated frequency of use—*almost never* to *very often*--(teaching, learning, principal, parent, and friend' interest in science) or level of agreement/disagreement (nature of science and student views about science). All student responses to the questionnaires and the content tests were analyzed using Item Response Theory (Rasch Model). Teacher responses to the content tests also were analyzed using IRT.

The evaluators examined if participants had changed their teaching/learning strategies and if student science achievement had improved. Table 1 shows the comparison of Cohort A teachers' responses on subscales "What I do in class" and "What my students do" before (pre) and after (final) participation in the STI. Cohort A MCEP teachers reported that they used standards-based teaching strategies significantly more often after they completed the STI project.

TABLE 1
Comparison of Cohort A Teacher Pre and Final Responses on the Teacher Questionnaire

Course	**Subscale**	**Time**	***M***	***SD***	***t***	***df***	***p***	**Cohen's *d***
MISEP	What I do in class	Pre	3.51	0.39	-1.20	15	0.250	-0.38
		Final	3.65	0.38				
	What my students do	Pre	3.38	0.40	-1.86	14	0.084	-0.73
		Final	3.65	0.32				
MCEP	What I do in class	Pre	3.07	0.28	-3.55	14	**0.003**	-1.15
		Final	3.43	0.34				
	What my students do	Pre	3.10	0.46	-2.04	14	0.060	-0.71
		Final	3.40	0.38				

Table 2 provides the comparison of Cohort B teachers' responses on some subscales before (pre) and after (final) participation in the STI. MISEP teachers reported their students used standards-based learning strategies significantly more often after the teachers completed the STI project. MCEP teachers reported more frequently using standards-based teaching and learning strategies after the project as well.

Table 3 shows the paired-samples *t*-test comparisons of teachers' content test results before and after completion of the STI project for both cohorts. In all cases, there were significant increases in the teachers' scores after they completed the STI project.

Statistically significant differences were found, as shown in Table 4, for the subscales “What I do in class” and “What my teacher does in class” for both MISEP and MCEP students. MISEP students reported they experienced more standards-based teaching and learning activities in Post Year 1, Post Year 2, and after their teacher completed the STI project. MCEP students, on the other hand, reported that they experienced standards-based teaching and learning activities more often in Post Year 2. These student responses supported and validated the teacher responses, provided in Table 2.

TABLE 2

Comparison of Cohort B Teacher Pre and Final Responses on the Teacher Questionnaire

Course	**Subscale**	**Time**	***M***	***SD***	***t***	***df***	***p***	**Cohen's *d***
MISEP	What I do in class	Pre	3.32	0.51	-0.96	8	0.363	-0.33
		Final	3.48	0.47				
	What my students do	Pre	3.07	0.50	-2.48	8	**0.038**	-0.85
		Final	3.41	0.27				
MCEP	What I do in class	Pre	3.09	0.46	-2.30	10	**0.044**	-0.92
		Final	3.48	0.38				
	What my students do	Pre	3.08	0.50	-2.93	10	**0.015**	-0.68
		Final	3.41	0.46				

TABLE 3

Comparisons of Teachers’ Pre and Final Content Test Scores: Cohort A and B: MISEP and MCEP

Cohort and Course	**Time**	***n***	***M***	***SD***	***t***	***df***	***p***	**Cohen's *d***
Cohort A MISEP	Pre (2005)	21	43.96	5.76	-12.80	20	**< 0.001**	-2.70
	Final (2007)	21	58.24	4.75				
Cohort A MCEP	Pre (2005)	17	45.16	6.17	-7.67	16	**< 0.001**	-1.72
	Final (2007)	17	56.55	7.07				
Cohort B MISEP	Pre (2006)	11	50.41	3.90	-8.69	10	**< 0.001**	-1.89
	Final (2008)	11	59.07	5.18				
Cohort B MCEP	Pre (2006)	14	41.30	6.54	-4.06	13	**0.001**	-1.47
	Final (2008)	14	50.44	5.84				

TABLE 4

Comparisons of Rasch Subscale Mean Scores of Cohort A Students: Pre and Final

Course	Subscale		*n*	*M*	*SD*	*F*	*df*	*p*	η^2
MISEP	What I do in class	Pre*	555	46.68	4.83	13.92	3, 1514	**< 0.001**	0.03
		Post1	413	48.41	4.93				
		Post2	358	48.10	4.36				
		Final	192	48.39	4.50				
	What my teacher does in class	Pre*	552	60.50	12.31	5.76	3, 1505	**0.001**	0.01
		Post1	410	62.89	13.10				
		Post2	357	63.29	10.98				
		Final	190	63.49	11.04				
MCEP	What I do in class	Pre	362	46.70	5.87	5.51	2, 729	**0.004**	0.01
		Post2**	250	48.08	5.80				
		Final	120	46.28	6.05				
	What my teacher does in class	Pre	362	57.16	12.19	3.40	2, 727	**0.034**	0.01
		Post2***	249	58.60	10.62				
		Final***	119	55.23	12.66				

* Mean scores for Post 1, Post 2, and Final are significantly higher than Pre score.

**Mean score for Post 2 is significantly higher than Pre and Final scores.

*** Mean score for Post 2 is significantly higher than Final score, but neither Post 2 nor Final scores are significantly different from Pre score.

Comparisons also were made for achievement tests scores for students of Cohort A teachers in 2005 (Pre), 2006 (Post Year 1), 2007 (Post Year 2), and 2008 (Final). MISEP students' achievement test mean scores increased over time, and Post Year 2 mean score (M = 59.14, SD = 10.75) as well as Final mean score (M = 59.49, SD = 12.62) were significantly higher than the mean scores of the previous two years [F (3, 1286) = 11.14, $p < 0.001$, $\eta^2 = 0.03$]. MCEP students' achievement test was unavailable and thus not given to Cohort A students in 2005 and 2006. High school chemistry students' mean achievement score in Post Year 2 (2007) (M = 43.23, SD = 11.37) was significantly higher than their final mean score (M = 39.60, SD = 12.27) with t (239) = 2.29, p = 0.023, Cohen's d = 0.31.

Multiple regression analyses examined whether gender, student group (i.e., White and Non-White), teacher's content knowledge level, or student questionnaire subscale scores predicted achievement scores for students of Cohort A teachers. As shown in Table 5, the combination of variables explained approximately 18% of the variance for MISEP students and 60% of the variance for MCEP students. For MISEP students, student group (favoring White students) and teacher content knowledge level were significant predictors of achievement. For MCEP students, the demographic variables of gender (favoring boys) and student group (favoring White) were significant predictors. In addition, teacher content knowledge and student subscale scores on "What I do in class", "What my teacher does in class", "What parents/adults do", and "My views of science" significantly predicted achievement[1].

[1] Students of Cohort B teachers have not yet taken the final achievement test.

TABLE 5
Multiple Regression Analyses for Cohort A Student Achievement Test Scores: Spring 2008 Data

Predictors	MISEP (n = 140)	MCEP (n = 78)
Gender	0.07	0.19 **
Student Group	0.32 ***	0.36 ***
Teacher Content Knowledge	0.19 *	0.47 ***
What I do in class	-0.04	-0.22 *
What my teacher does in class	0.00	0.19 *
What my friends do	0.20	0.03
What parents/adults do	-0.01	-0.24 **
My views of science	0.10	0.49 ***
Adj R^2	0.18	0.60

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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5. Key insights that have value for the Learning Network:

Sustained professional development focused on increasing teacher content knowledge, changes teaching practices and enhances teacher content knowledge. Student achievement is enhance by increased teacher content knowledge, more frequent used of inquiry, and more accurate understanding of the nature of science. These positive student changes are statistically significant for older students (MCEP). However, the gaps in achievement due to student gender and race/ethnicity also are significant for older students.

References

National Academy of Science. (2005). *Rising above the gathering storm: energizing and employing America for a brighter economic future*. Committee on Prospering in the 21st Century. Washington, DC.

National Science Foundation. (2007). *Student results show benefits of math and science partnerships*. Retrieved August 1 from http://www.nsf.gov/news/news_summ.jsp?cntn_id=109725&org=olpa&from=news