RIP~ing @ Science in Bloomfield Schools

Impact Evaluation: Data Analysis Summary Report For Jan-May 2012

ANOVA Science Education Corporation, Honolulu, HI

BLOOMFIELD TEACHER PROFESSIONAL DEVELOPMENT IMPACT

The purpose of this professional development program was to introduce K-12 teachers at Bloomfield, NM, to the teaching of science (and other content areas where appropriate) through true scientific inquiry, using the *Research Investigation Process* (RIP) as a tool for addressing the *New Mexico Science Content Standards, Benchmarks, and Performance Standards* (*NMSCS*); the *National Science Education Standards* (*NSES*); and the *New Generation Science Standards* in the classroom. Specifically, it was designed to guide teachers in the use of the inquiry process (the practices used by scientists in their everyday endeavors to learn about the natural world); to have teachers learn how to design and conduct scientific research studies; to have them become familiar with techniques to assist in guiding students through the scientific inquiry process; to have them examine, practice, understand, and become competent in their ability to apply data analysis techniques to decision-making in science; to increase confidence in using scientific research in their approach to instructing students in science and in addressing the scientific inquiry benchmarks and science inquiry content standards; to have them implement the RIP as a tool for instruction in the classroom for all content areas; and to increase student interest in learning science. To measure outcomes related to these goals, a multitude of items measuring change in knowledge, demonstrated ability to apply the knowledge, and self-reported attitudes and confidence of the teacher participants were included in the assessment tools that were used to collect evidence.

The RIP implementation was initiated near the end of January and continued until the end of the school year (latter part of May). The professional development component included two workshop training sessions: a four-day initial training workshop and an end of the year one-day training workshop. Follow-up individual teacher videoconference sessions (2-3 per teacher) providing support for curriculum development and for reinforcing content from the training were conducted after the initial 4-day training session through the subsequent two months. Additionally, each teacher was supported with two in-the-classroom co-teaching/mentoring sessions with the RIP trainer to help them through the process of learning how to integrate knowledge and skills developed from the workshop into classroom instruction and to bolster their confidence in doing so.

Over the course of the four-day workshop sessions conducted during the last week of January and the first week of February, 2012, the *Research Investigation Process* (RIP) was introduced and teachers were provided the opportunity to develop an understanding of each of the elements of scientific inquiry through their participation in and development of actual research investigations. Teacher participants were guided through a number of activities related to making observations; posing research questions; obtaining, examining, and evaluating background information; constructing hypotheses; and designing the methods for a research investigation. Techniques in data summary, analysis and presentation were explored in the context of hypothesis testing and decision-making in science. Teachers were then expected to introduce workshop-related concepts and activities learned into their classroom through guided inquiries over the remainder of the second half of the 2011-2012 academic year (approximately 3.5 months). Due to state testing of students, most teacher participants reported to have actually used the RIP in the classroom for no more than two months over this implementation period. Each teacher also participated in two to three videoconferencing sessions for the purposes of being mentored for further understanding of the inquiry process components and in curriculum development. These individual teacher follow-up sessions involved modeling of instructional

techniques and practices with students, assisting teachers on inquiry-based curriculum development in various content areas, and/or clarifying concepts presented in the initial four-day workshop session. The participants met together again at the End-of-Year Training Workshop/Assessment Session. During this follow-up session, participants shared their inquiry-based instructional experiences and student outcomes and practiced assessment in inquiry-based instruction. Only seven participants attended the End-of-Year Workshop Session, as it was held after the school year ended and the remaining teachers had conflicting commitments. All aspects of this workshop were aligned with accepted standards-based teaching and assessment practices and the *NMSCS* and *NSES*.

Thirteen teacher participants attended the initial four-day training workshop, and all but one of these implemented the RIP into their classrooms and received at least two curriculum development and two in-classroom mentoring support sessions. The data for this program evaluation were obtained from assessments of the teacher-participants prior to the initial RIP four-day training workshop (Pre-Workshop Assessment), at the end of the training workshop (Post-Workshop Assessment), and at the final workshop session at the end of the year (End-of-Year Assessment). An attitude/opinion questionnaire was administered as part of the Post- and End-of-Year assessments to determine the impact of participating in this program on participants' attitudes and opinions toward instructing students in science through scientific inquiry, science, and the impact of the inquiry-based instruction on their students. Five of the 12 participants who completed classroom implementation did not attend the one-day summer End-of-Year follow-up training session and did not submit an End-of-Year Assessment and one of the 12 completed a Pre- and End-of-Year, but no Post-Workshop Assessment.

Items on the assessments required demonstration of knowledge about the scientific inquiry process, data analyses procedures, and decision-making in science. A number of these items required teachers to demonstrate their knowledge through application. Self-report items measured teacher confidence levels in understanding and using scientific inquiry in the classroom and in comprehending and applying the scientific inquiry content standards to their instruction. The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value), and "completely confident" ('12'-value). A concept inventory determined teachers' familiarity with and ability to teach elements of scientific inquiry and data summary and analysis techniques. The answer scale for the concept inventory items included "I am completely unfamiliar with this concept" (value=1), "I am somewhat familiar with this concept, but do not really understand what it means" (value = 2), "I am familiar with this concept, and have a fair understanding of what it means" (value = 3), "I am very familiar with this concept, but would have much difficulty teaching it to others" (value = 4), "I am very familiar with this concept and could teach it to others with some difficulty" (value = 5), "I am very familiar with this concept and could teach it to others with little difficulty" (value = 6), and "I am very familiar with this concept and could easily teach it to others" (value = 7).

The pre-workshop, post-workshop and End-of-Year assessment items were the same. A Post-Workshop Questionnaire containing five items was also administered to assess the teachers' perceptions of how much their understanding of the scientific inquiry process and *NMSCS* changed and improved as a result of participation in the workshop. The End-of-Year Questionnaire contained the same teacher confidence and perception items as on the Post-Workshop Questionnaire, as well as additional items related to teacher perceptions of the impact of the RIP program at Bloomfield and the RIP on their students' and their own understanding,

confidence, and interest levels as they pertain to learning science, scientific inquiry, and science instruction. Some of the items on the questionnaires required teachers to draw a vertical line on a continuous scale containing 5 or 8 anchors ranging from "none" to "completely," "none" to "an extremely large amount," "remained unchanged" to "dramatically increased," and "not at all confident" to "completely confident." Other items used a Likert-type scale requiring the circling of the response ranging from "greatly decreased" to "greatly increased" and "strongly disagree" to "strongly agree,"

The Pre-, Post-, and End-of-Year Assessment data were statistically analyzed using one-way repeated measures ANOVAs to determine significant differences (indicating change) between assessment mean values. When comparing more than two means, following a significant effect, the Holm-Sidak method was used for multiple comparisons. General linear model ANOVAs were used to accommodate the data that included the participant with missing values for the Post-Workshop Assessment and participants with missing values for the End-of-Year Assessment. The criterion for statistical significance (α) for all tests was set at 0.05.

An additional evaluation from the LETQP was administered to the teacher participants (n=12) who completed the initial four-day RIP training workshop to assess the performance of the RIP trainer and training program. This training evaluation contained five scale items assessing quality of organization, presentation, materials, activities, and pacing. This evaluation also contained three open-ended response items and an optional message from the teacher participant to the presenter.

All assessments and questionnaires were administered anonymously using teacher codes provided by the school. The assessments and questionnaires were self-administered by a designated teacher and returned to the Program Director and/or the evaluator at the end of each assessment session for scoring and data analysis.

This report provides an evaluator's overall summary of the impact of the RIP program on Bloomfield teachers and their perceptions of RIP impact on their students, followed by detailed narrative and supporting data. Summarized data and questionnaire responses from the presenter evaluation appear at the end of this evaluation.

Evaluator's Summary:

The Bloomfield teachers showed large gains in their knowledge of scientific inquiry and developed the necessary skills to use this process (see Figures 1, 6, 7 and 8, below). The largest gains were observed following the initial training session.

Accompanying the substantial increases in their demonstrated knowledge and skills were significant increases in teachers' recognition that they were becoming more knowledgeable about the inquiry components and process, and progressing towards being able to teach this process to their students (Figures 2, 9, and 13.) The largest gains were again made following the initial training workshop for concepts relating to the scientific inquiry process, data analysis, and inquiry standards concepts. Participants consistently reported being "very familiar" by the end of the year on all concepts presented to them, but at the same time varied between being able to teach the concepts to their students with much difficulty and little difficulty. Similar increases

were achieved in teacher self-perceived understanding of and ability to teach the scientific inquiry standards.

Teacher-reported confidence rose significantly to the level of "confident" or above confident regarding knowledge of scientific inquiry and the ability to implement the inquiry process as an instructional tool in the classroom at the end of the initial training workshop (Figures 3 and 5). Statistically significant gains in self-reported understanding and ability to apply scientific inquiry to the teaching of science were demonstrated on both the Post- and End-of-Year Assessments, indicating the impact of continued support of the teachers as they implemented the RIP into the classroom (Figure 4).

Teacher confidence in their ability to successfully address the science content standards and scientific inquiry benchmarks also increased significantly to "very confident" by end of the year (Figures 11 and 12, respectively). In addition, they reported at the end of the year being "very confident" to "completely confident" about their knowledge of the scientific inquiry standards they taught and in their ability to accurately and completely address the scientific inquiry benchmarks compared to before they became involved in the RIP program (Figures 29 and 30, respectively).

Participation in this program resulted in increased or greatly increased and/or enhanced use of ongoing assessment in inquiry-based instruction for six of the seven teachers, while the one remaining teacher reported a slight increase (Figure 28). Teachers reported themselves to be "confident" to "very confident" in their ability to apply formative assessment to measure their students' understanding and application of scientific inquiry (Figure 27).

All seven teachers reported that their use of scientific inquiry in the classroom "increased" or "greatly increased" since learning the RIP, and that engaging students in learning science through inquiry "increased" or "greatly increased" their interest in learning science (Figures 26 and 24, respectively).

Teachers directly attributed all of their gains related to inquiry-based instruction knowledge, skills, and confidence to a large extent to the RIP program (Figures 10, 14, 15, and 25). Further, they felt that their use of the RIP compared to previous instruction methods largely increased their students' ability and motivation to learn science (Figures 22 and 23, respectively). The teachers also attributed student change and positive gains in their students' understanding of scientific inquiry to their participation in the RIP program (Figures 18-21).

Teacher reflections supported the quantitative assessment results. Teacher #3 wrote, "This program has inspired me to move in different directions, in my classroom, in my education, and in my personal life...I appreciate your pushing me along to something new and worthwhile." Additional teacher comments can be viewed at the end of the narrative below.

Evidence for RIP Implementation into Bloomfield School Classrooms

Items on the teacher End-of-Year Assessment requested information regarding the number of inquiries that the Bloomfield teachers conducted with their students over the implementation period. Teachers were initially trained during the end of January into the first week of February, 2112. The teachers averaged almost five (4.86) scientific inquiries, of which 1.86 were extended (lasting more than 1 or 2 class periods), during Quarters 3 and 4 (Table 1).

Teacher	Quarter 3 inquiries	Quarter 4 inquiries	2-Quarter total	% instruct-ion time
1	3 (2)	3 (1)	6 (3)	95
3	3 (2)	3 (0)	6 (2)	25
4	1 (1)	2 (1)	3 (2)	20
6	3 (2)	6 (1)	9 (3)	40
5-2	0 (0)	2 (0)	2 (0)	10
6-2	0 (0)	5 (1)	5 (1)	60
9-2	1 (1)	2 (1)	3 (2)	15
Mean	**2.75 (1.14)**	**3.29 (0.71)**	**4.86 (1.86)**	**38**

Table 1. The number and mean number of self-reported class scientific inquiries and extended inquiries (shown in parentheses) conducted by Bloomfield School teachers per academic quarter. Also shown is the percent of total instruction time during which scientific inquiry was used for instruction with their students. (Five teachers did not take the End-of-Year Assessment.)

More, but fewer extended inquiries were conducted for Quarter 4 (3.29 and 0.71) compared with Quarter 3 (2.75 and 1.14).

There was a wide range in teacher instructional time spent teaching through scientific inquiry, ranging from a low of 10 percent to a high of 95 percent. The mean amount of total instruction during which teachers used scientific inquiry-based instruction was 38 percent over the two quarters.

Bloomfield Teacher Knowledge and Understanding of the Scientific Investigation Process, and Confidence in Teaching Scientific Inquiry

Bloomfield's teacher participants demonstrated a large, statistically significant increase in their knowledge and understanding of the individual elements of the scientific process, more than doubling their assessment scores compared to pre-workshop levels by the end of the initial 4-day workshop session (Post; Figure 1, below). Participant demonstration of understanding/ knowledge of scientific inquiry was maintained at this new level at the end of the year (End-of-Year; Figure 1, below). This assessment section included the logical order of the elements of scientific inquiry, understanding of components involved in each element, and demonstration of the ability to construct a testable hypothesis.

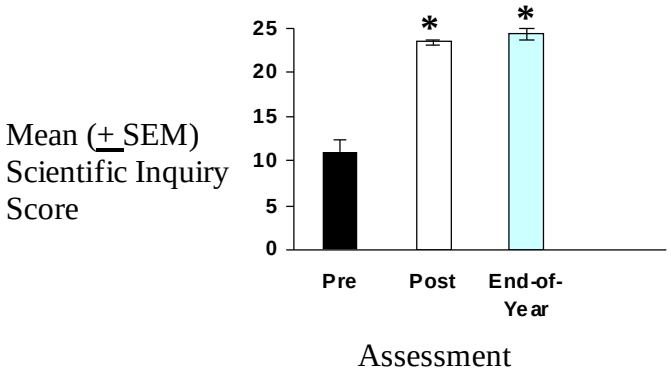

Figure 1. Demonstration of knowledge and understanding of the elements of scientific inquiry. This section was worth a total of 25 points. N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 79.40$, $p<0.001$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 11.23$, $p<0.006^{-6}$ and $t = 9.47$, $p<0.006^{-5}$, respectively.

The increase in teacher-participant knowledge and understanding of the scientific research process from the Pre initial workshop assessment (Pre-Assessment) level was accompanied by a significant increase in teacher' self-reported familiarity and understanding of concepts related to

the scientific research process in the concepts inventory (Figure 2, below). The average participant' response rose from between being "familiar" with the concept with "fair understanding of what it means" and being "very familiar with the concept but having "much difficulty teaching it to others" to "very familiar with concept and could teach it to others with some difficulty" following the 4-day training workshop and continuing throughout the year. This showed that teachers recognized their increased knowledge and understanding. Although not a statistically significant change, the teacher scientific process concept inventory value appeared to trend higher from the post-workshop to the End of Year assessment (Figure 2, below).

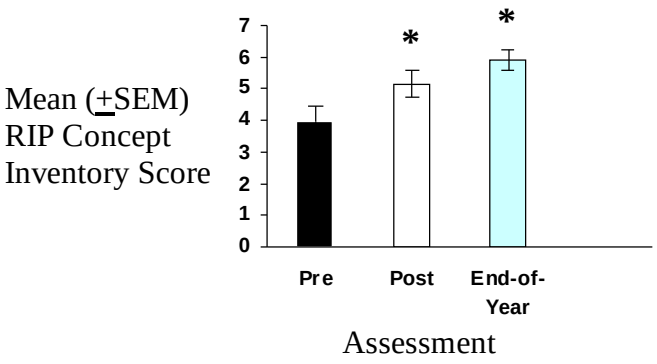

Figure 2. Familiarity and understanding of concepts related to elements of the RIP. The answer scale for the concept inventory items included "I am completely unfamiliar with this concept" (value=1), "I am somewhat familiar with this concept, but do not really understand what it means" (value = 2), "I am familiar with this concept, and have a fair understanding of what it means" (value = 3), "I am very familiar with this concept, but would have much difficulty teaching it to others" (value = 4), "I am very familiar with this concept and could teach it to others with some difficulty" (value = 5), "I am very familiar with this concept and could teach it to others with little difficulty" (value = 6), and "I am very familiar with this concept and could easily teach it to others" (value = 7). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 9.51$, $p=0.002$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 3.73$, $p<0.002$ and $t = 3.48$, $p=0.003$, respectively.

By the end of the initial 4-day workshop (Post-Assessment), teacher participant' self-reported confidence level for ability to use scientific inquiry and for understanding of teaching science through inquiry increased significantly from "somewhat confident" to near "confident" (Figures 3 & 4, below). At the end of the year, teacher confidence was near "very confident" for both items significantly increasing again compared to the Post-Assessment value for the latter item. Confidence in ability to teach and engage students in scientific research activities significantly increased, but not until the end of the year (Figure 5, below). The End-of-Year increases in teacher confidence reflect the effects of ongoing support activities involving curriculum development and mentoring, and suggest that the implementation of inquiry-based science instruction in the classroom and the follow-up activities positively impacted program-participants' confidence and maintained that confidence over the first year of implementation.

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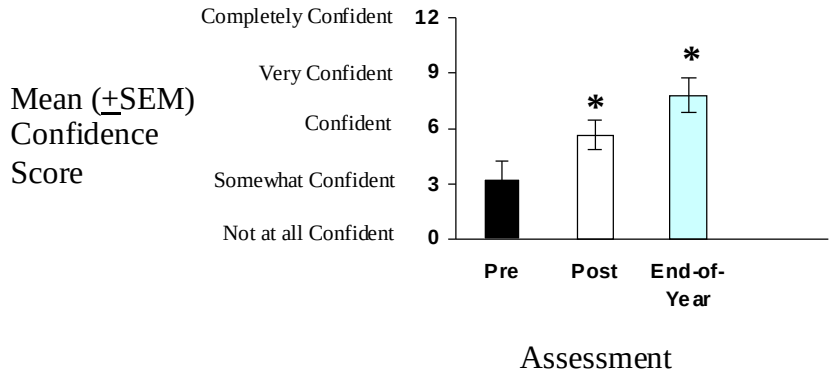

Figure 3. Self-reported confidence level for participants' "ability to use scientific inquiry as a tool for thinking, learning, and teaching science." The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 7.15$, $p<0.001$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 4.14$, $p<0.008^{-1}$ and $t = 5.38$, $p<0.007^{-2}$, respectively.

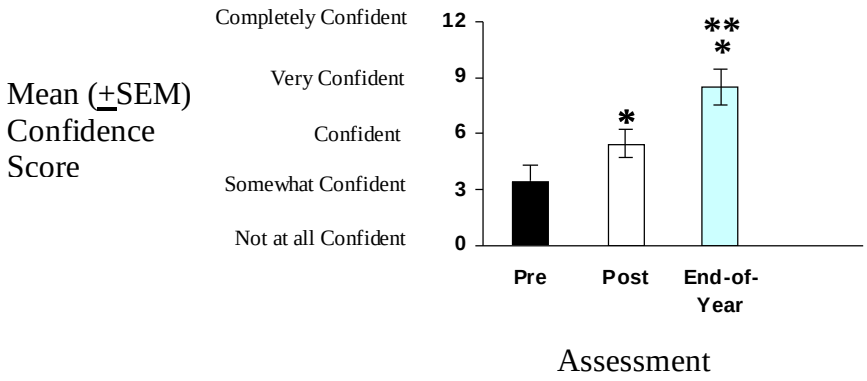

Figure 4. Self-reported confidence levels for understanding of teaching science through inquiry. The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 32.14$, $p<0.002$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 4.44$, $p<0.005^{-1}$ and $t = 7.85$, $p=0.008^{-4}$, respectively.

**Mean End-of-Year Assessment score is significantly greater than mean Post-Assessment score: $t = 4.06$, $p<0.009^{-1}$

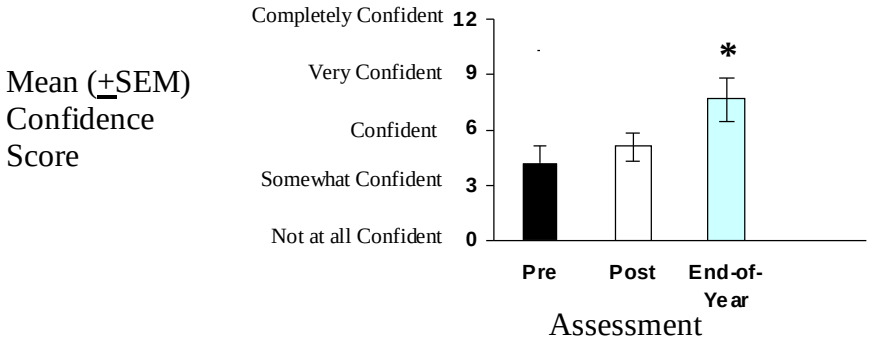

Figure 5. Self-reported confidence levels for ability to teach and engage students in scientific research activities. The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 7.34$, $p<0.005$.

*Mean End-of-Year Assessment score is significantly greater than mean Pre-Assessment score: $t = 3.82$, $p<0.002$.

Bloomfield Teacher Understanding of and Ability to Apply Data Summary, Presentation, and Analysis Techniques for Decision-Making in Science

By the end of the initial 4-day workshop (Post-Assessment), participants demonstrated a large, statistically significant increase in their knowledge and understanding of data summarization and ability to correctly organize data into a summary table and to construct a bar graph for comparing the central tendency of two groups of data (Figure 6, below). This more than doubling of the Pre-Assessment value was maintained at the end of the year.

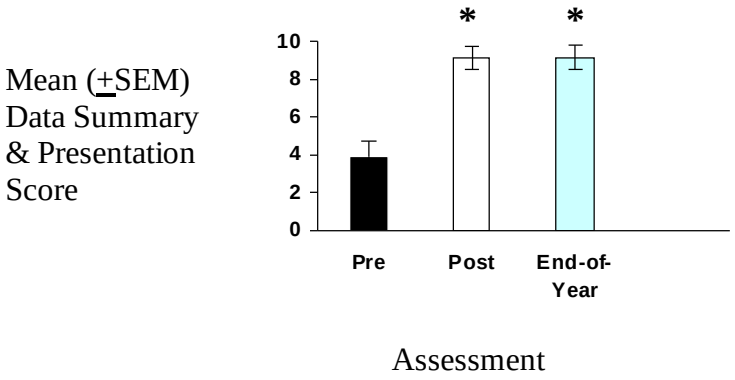

Figure 6. Demonstration of understanding and ability to apply data organization and presentation techniques to data. This section was worth a total of 10 points. N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 24.32$, $p<0.001$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 6.34$, $p<0.001^{-2}$ and $t = 5.05$, $p<0.002^{-1}$, respectively.

Workshop participants also demonstrated a large change in their knowledge and ability to apply data analysis techniques to research data at the end of the initial four-day training workshop and at the end of the year. Comparison of the pre-and post-assessments revealed that by the end of the initial 4-day workshop (Post-Assessment) and at the end of the year, participants significantly increased their understanding of how to calculate descriptive statistics and their ability to determine which measure of central tendency is most appropriate for describing a group of data (Figure 7, below).

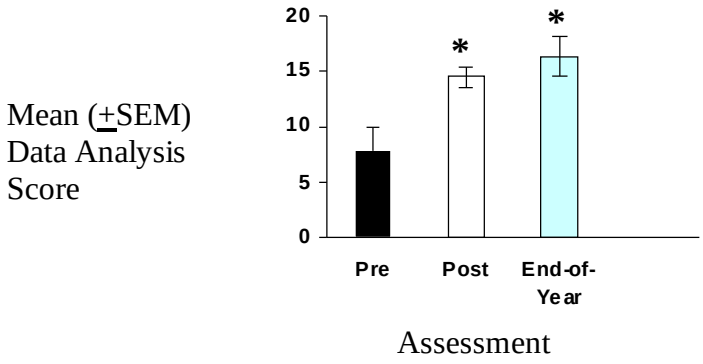

Figure 7. Demonstration of understanding the calculations for descriptive statistics and ability to determine the most appropriate statistic to represent central tendency for a group of data. This section was worth a total of 20 points. N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 9.90$, $p<0.002$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 3.24$, $p<0.006$ and $t = 4.03$, $p<0.001$, respectively.

Teacher-participants nearly doubled their mean score at the end of the 4-day initial training workshop and demonstrated a statistically significant increase in their ability to correctly interpret data presented in scatterplots and summarized in bar graphs, including an understanding of error. By the end of the year (End-of-Year Assessment), the participants' mean data interpretation skills did double compared to the Pre-Assessment value (Figure 8, below).

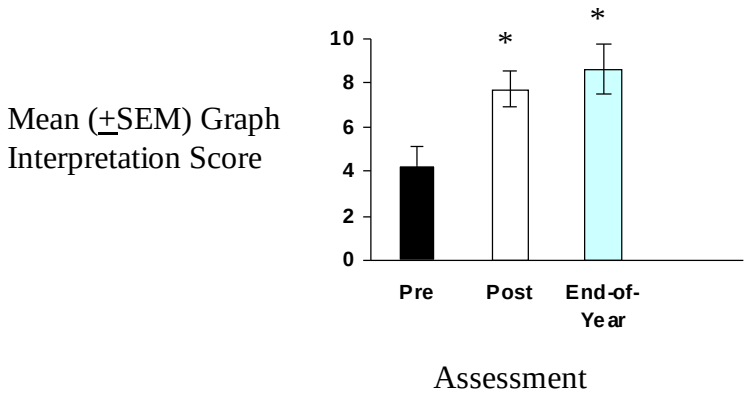

Figure 8. Demonstration of ability to interpret scatterplots and bar graphs. This section was worth a total of 10 points, not including an extra-credit item worth 2 points. N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 6.90$, $p=0.007$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 3.37$, $p<0.004$ and $t = 2.70$, $p<0.02$, respectively.

The increases in teacher-participant demonstrated knowledge of and ability to apply data presentation and analyses were accompanied by significant increases in teacher' self-reported familiarity and understanding of concepts related to summarizing, analyzing, and presenting data (Figure 9 below). The average participant' response for measures of central tendency, data presentation including tables and graphs, and the concept of uncertainty and error in decision-

making rose significantly from Pre-Assessment values of between "somewhat familiar with concept, but do not really understand what it means" and "familiar with this concept, and have a fair understanding of what it means" to between "very familiar with concept with some difficulty teaching it to others" and "very familiar with concept and could teach it to others with little difficulty" by the end of the year (Figure 9).

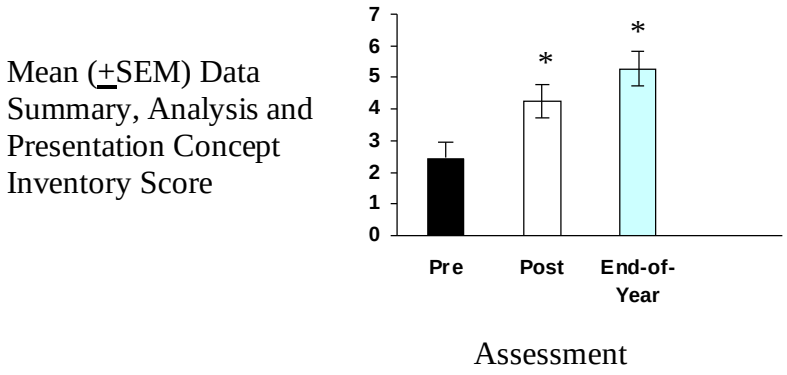

Figure 9. Familiarity and understanding of concepts related to measuring central tendency, variability, and presenting data in tables and graphs. The answer scale for the concept inventory items included "I am completely unfamiliar with this concept" (value=1), "I am somewhat familiar with this concept, but do not really understand what it means" (value = 2), "I am familiar with this concept, and have a fair understanding of what it means" (value = 3), "I am very familiar with this concept, but would have much difficulty teaching it to others" (value = 4), "I am very familiar with this concept and could teach it to others with some difficulty" (value = 5), "I am very familiar with this concept and could teach it to others with little difficulty" (value = 6), and "I am very familiar with this concept and could easily teach it to others" (value = 7). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 18.02$, $p<0.001$.

*Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 4.86$, $p<0.002^{-1}$ and $t = 5.07$, $p<0.002^{-1}$, respectively.

At the end of the year, program participants reported that their understanding of how to analyze and interpret data "increased substantially" as a result of participation in the RIP program (Figure 10, below).

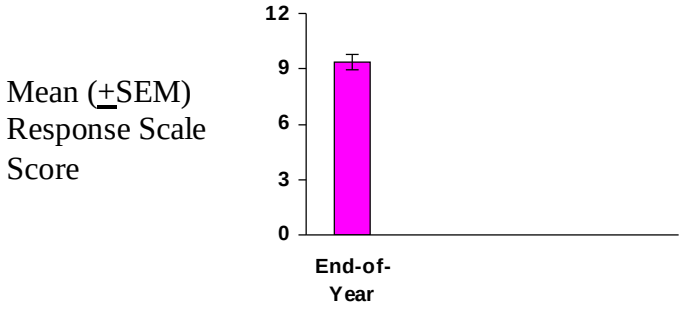

Figure 10. End-of-Year Questionnaire teacher response to "As a result of my participation in the program, my understanding of how to analyze and interpret research data has _____." The response scale included "remained unchanged" ('0'-value), "slightly increased" ('3'-value), "moderately increased" ('6'-value), "substantially increased" ('9'-value), and "dramatically increased" ('12'-value). N=7 Bloomfield teachers.

Benchmarks and Standards

General teacher confidence and awareness of ability to understand and apply scientific inquiry to the teaching of science and in ability to successfully address the science content standards did not significantly change until the end of the year, when confidence levels reach "very confident." Teacher-participant self-reported confidence in ability to address science content standards in the classroom rose significantly, from between "somewhat confident" and "confident" to "confident" by the end of the initial workshop (Post-Assessment) [Figure 11, below].

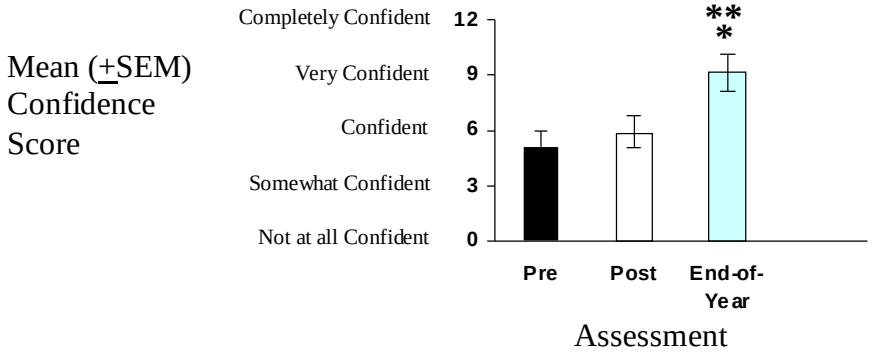

Figure 11. Self-reported confidence levels for ability to address science content standards in the classroom. The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 16.38$, $p<0.001$.

*Mean End-of-Year Assessment score is significantly greater than mean Pre-Assessment score: $t = 5.71$, $p<0.004^{-2}$

**Mean End-of-Year Assessment score is significantly greater than mean Post-Assessment score: $t = 4.20$, $p<0.007^{-1}$

Similarly, participants' confidence in their ability to accurately and completely address the scientific inquiry benchmarks more than doubled, significantly increasing from slightly above "somewhat confident" on the Pre-Assessment to "very confident" at the end of the year (Figure 12, below).

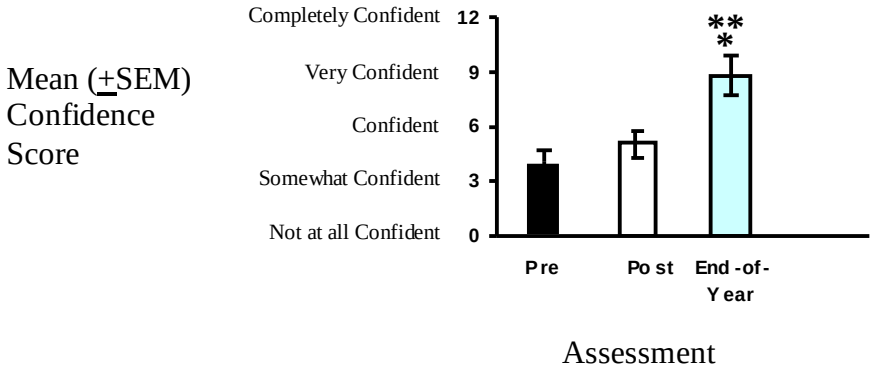

Figure 12. Self-reported confidence levels for ability to accurately and completely address the scientific inquiry benchmarks with students. The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 14.96$, $p<0.001$.

*Mean End-of-Year Assessment score is significantly greater than mean Pre-Assessment score: $t = 5.46$, $p<0.006^{-2}$

**Mean End-of-Year Assessment score is significantly greater than mean Post-Assessment score: $t = 3.91$, $p<0.002$

Finally, at the end of the initial training workshop, the teacher participants increased their familiarity and understanding of scientific inquiry and the inquiry standards. Prior to training, teachers reported themselves between "somewhat familiar with this concept, but not really understanding what it means" and "I am familiar with this concept, and have a fair understanding of what it means." Immediately following the workshop, the teachers reported themselves to be between "very familiar with this concept and could teach it to others with much difficulty" and very familiar and could teach it with some difficulty" (Figure 13, below). This increase was statistically significant and consistent with the increase in teacher-participant confidence regarding addressing the science content standards and scientific inquiry benchmarks (Figures 11 and 12, above).

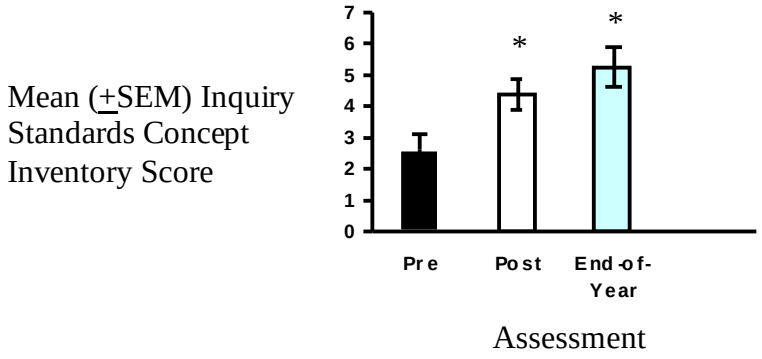

Figure 13. Familiarity and understanding of the inquiry standards concept. The answer scale for the concept inventory items included "I am completely unfamiliar with this concept" (value=1), "I am somewhat familiar with this concept, but do not really understand what it means" (value = 2), "I am familiar with this concept, and have a fair understanding of what it means" (value = 3), "I am very familiar with this concept, but would have much difficulty teaching it to others" (value = 4), "I am very familiar with this concept and could teach it to others with some difficulty" (value = 5), "I am very familiar with this concept and could teach it to others with little difficulty" (value = 6), and "I am very familiar with this concept and could easily teach it to others" (value = 7). N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The data were analyzed with a one-way repeated measures ANOVA: $F(2, 16) = 16.97$, $p<0.001$.

* Mean Post- and End-of-Year Assessment scores are significantly greater than mean Pre-Assessment score: $t = 4.87$, $p<0.002^{-1}$ and $t = 4.78$, $p<0.003^{-1}$, respectively.

Bloomfield Teacher Perceptions of Overall Impact of the Initial 4-day Workshop and Sustained Support during Implementation on Their Understanding of and Ability to Implement Standards-Based Inquiry

The Post and End-of-Year Workshop Questionnaires contained four self-report items designed to assess how much teacher-participants believed their knowledge and abilities regarding scientific inquiry were impacted by their participation in the 4-day workshop and overall RIP program. The results from these items are presented in Figures 14-17 below.

The workshop-participants indicated that their understanding of the scientific inquiry process was changed a "large amount" following the initial workshop and at the end of the year after follow-up support and classroom implementation of implementation of the RIP into the classroom (Figure 14, below).

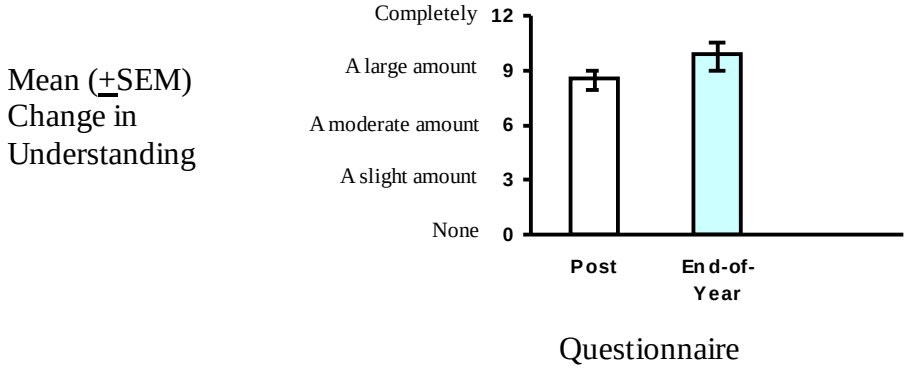

Figure 14. Post 4-day initial workshop (Post) and End-of-Year participants' responses to "what extent, if any, did your understanding of the scientific inquiry process change as a result of your participation in this program?" The scale for responses included "none," "a slight amount," "a moderate amount," "a large amount," and "completely." N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

The teachers also claimed that their understanding of scientific inquiry ***improved*** a "large amount" as a result of their participation in the RIP program (Figure 15, below).

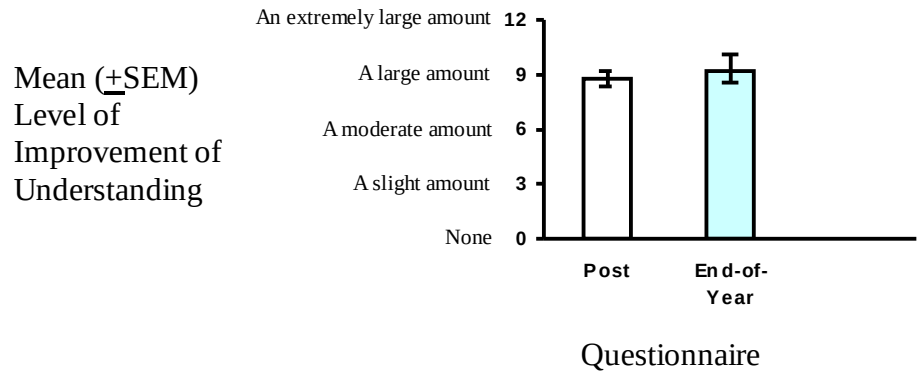

Figure 15. Post 4-day initial workshop (Post) and End-of-Year participants' responses to "what extent, if any, did your understanding of the scientific inquiry process improve as a result of your participation in this program?" The scale for responses included "none," "a slight amount," "a moderate amount," "a large amount," and "an extremely large amount." N=7 Bloomfield teachers. One teacher did not submit a Post-Assessment; 5 teachers did not submit an End-of-Year Assessment.

More than four-fifths of the participants (86%) either "strongly" or "moderately" agreed that their involvement in the RIP program increased their ability to engage their students in standards-based science learning through scientific inquiry, while one teacher "slightly agreed" with this statement (Figure 16, below).

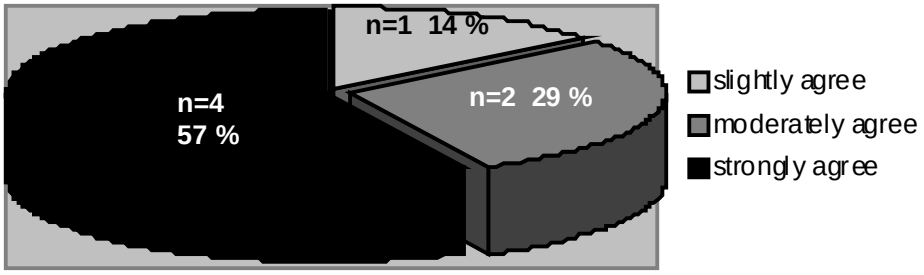

Figure 16. Pie chart representing teacher-participants' degree of agreement with "My involvement in this program has increased my ability to engage my students in standards-based science learning through scientific inquiry." The scale for responses included "strongly disagree," "moderately disagree," "slightly disagree," "neutral," "slightly agree," "moderately agree," and "strongly agree. N=7 Bloomfield teachers (5teachers did not submit an End-of-Year Assessment).

Eighty-five percent of the workshop-participants (6 of 7) "strongly" or "moderately" agreed that involvement in the RIP Program increased their ability to develop a standards-based unit incorporating the research investigation process, while one teacher only slightly agreed with this statement (Figure 17, below).

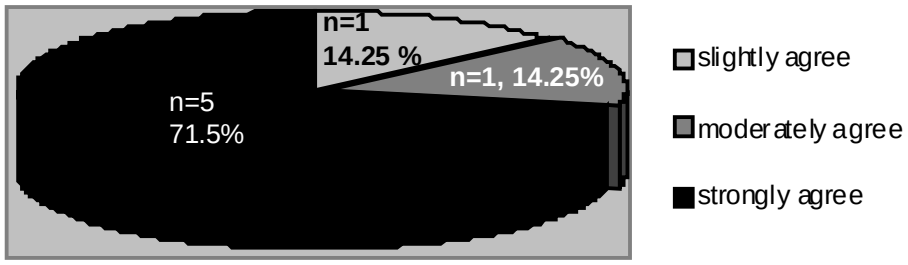

Figure 17. Pie chart representing teacher-participants' degree of agreement with, "My involvement in this program has increased my ability to develop a standards-based unit incorporating the research investigation process." The scale for responses included "strongly disagree," "moderately disagree," "slightly disagree," "neutral," "slightly agree," "moderately agree," and "strongly agree." N=7 Bloomfield teachers (5teachers did not submit an End-of-Year Assessment).

Bloomfield Teacher Perceived Impact of the RIP Program Implementation on Student Understanding of and Ability to Implement Standards-Based Inquiry, Interest in Science, and Motivation to Learn Science

The End-of-Year Questionnaire contained a number of items pertaining to teacher participants' perceived impact of program implementation on student understanding of and ability to apply scientific inquiry, and motivation and ability to learn science.

Teacher participants indicated that their own participation in this program resulted in "large" changes in their students' understanding of the scientific inquiry process (Figure 18, below) and responded that their students' understanding about scientific inquiry improved by a "large" to "extremely large amount" (Figure 19, below).

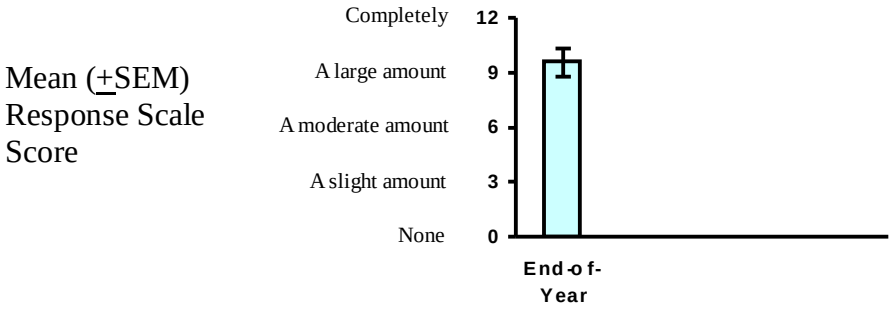

Figure 18. End-of-Year Questionnaire teacher response to "To what extent, if any, did your students' **understanding of the scientific inquiry process *change*** as a result of your participation in this RIP Program?" The response scale included "none" ('0'-value), "a slight amount" ('3'-value), "a moderate amount" ('6'-value), "a large amount" ('9'-value), and "completely" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

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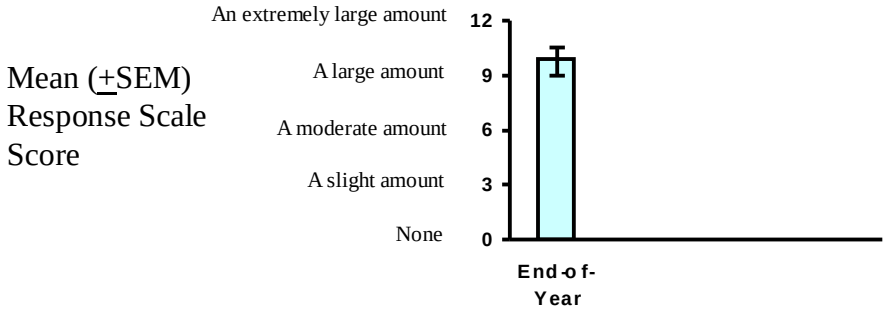


Figure 19. End-of-Year Questionnaire teacher response to "To what extent, if any, did your students' **understanding of the scientific inquiry process *improve*** as a result of your participation in this RIP Program?" The scale for responses included "none" ('0'-value)**,** "a slight amount" ('3'-value)**,** "a moderate amount" ('6'-value)**,** "a large amount" ('9'-value), and "an extremely large amount" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

Teachers felt that their own participation in the RIP program led to a "large" change in student understanding of the science content standards and a "large" to "extremely large" increase in student application of scientific inquiry (see Figures 20 and 21, respectively).

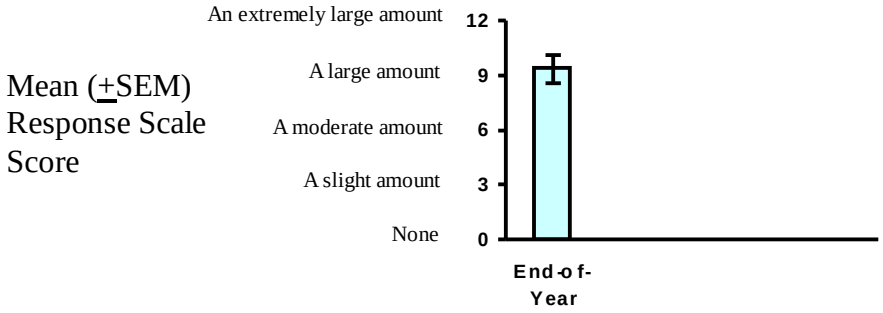


Figure 20. End-of-Year Questionnaire teacher response to "To what extent, if any, did your students' **understanding of the science content standards *change*** as a result of your participation in this RIP program?" The response scale included "none" ('0'-value), "a slight amount" ('3'-value), "a moderate amount" ('6'-value), "a large amount" ('9'-value), and "an extremely large amount" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

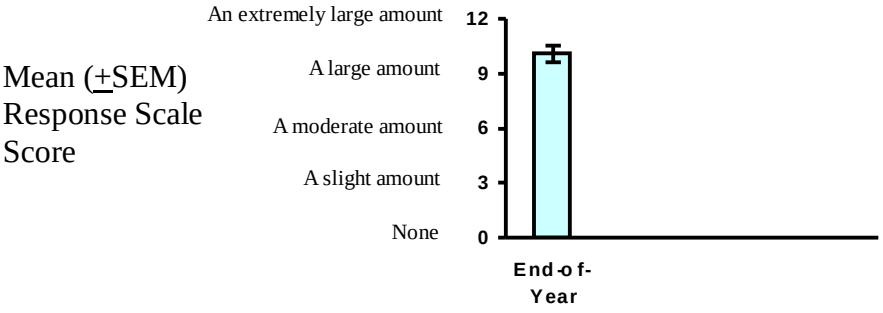


Figure 21. End-of-Year Questionnaire teacher response to "To what extent did your students **apply scientific inquiry** as a result of your participation in this RIP program?" The response scale included "none" ('0'-value), "a slight amount" ('3'-value), "a moderate amount" ('6'-value), "a large amount" ('9'-value), and "an extremely large amount" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

When asked to compare their instructional practices used in prior years to those used with the RIP, they reported that the RIP ***positively impacted*** their students' ability to learn science (and/or other content areas) between "a large amount" and "completely" [Figure 22, below]. Teacher 9-2 commented, "It was very helpful." According to teacher #3, "True scientific research energizes and excites my students much more than traditional methodology." Teacher #4 stated, "After completing an inquiry, my students were more motivated and excited to learn science."

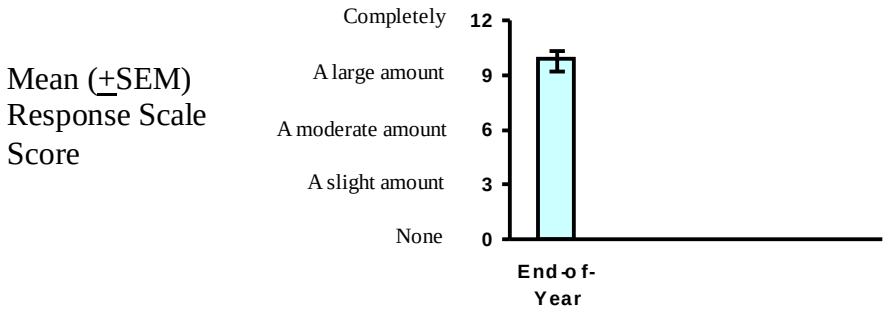


Figure 22. End-of-Year Questionnaire teacher response to "Compared to your instructional practices used in previous years, to what extent do you feel that the RIP inquiry-based instruction you used this year positively impacted your students' ***ability to learn science*** (and/or other content areas)?" The response scale included "none" ('0'-value), "a slight amount" ('3'-value), "a moderate amount" ('6'-value), "a large amount" ('9'-value), and "completely" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

Teacher-participant' perceptions of student attitudes towards science reflected a positive impact of using scientific inquiry as an instruction tool. The teacher participants responded that using the RIP, compared with their previously used instructional strategies, positively impacted their students' motivation to learn science (and/or other content areas) "a large amount."(Figure 23, below).

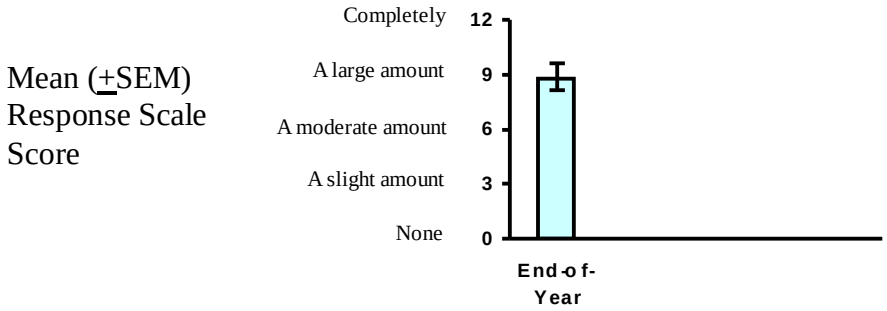


Figure 23. End-of-Year Questionnaire teacher response to "Compared to your instructional practices used in previous years, to what extent do you feel that the RIP inquiry-based instruction you used this year positively impacted your students' ***motivation to learn science*** (and/or other content areas)?" The response scale included "none" ('0'-value), "a slight amount" ('3'-value), "a moderate amount" ('6'-value), "a large amount" ('9'-value), and "completely" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

Teacher #4 wrote, "Motivation was very high!" According to Teacher 3, "Doing science was far better than just talking about it."

All of the participants felt that instruction through inquiry "increased" or "greatly increased" students' interest in learning science (Figure 24, below).

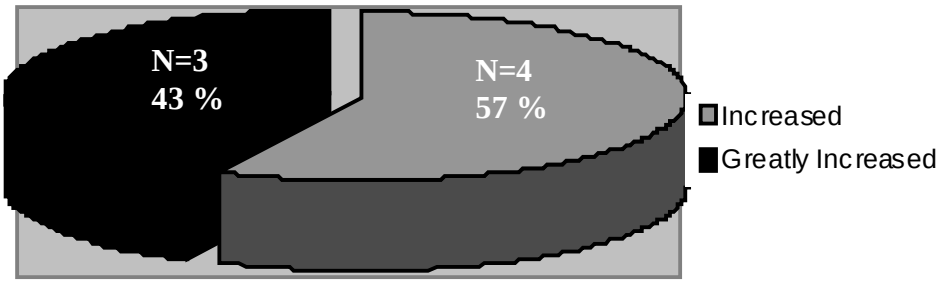


Figure 24. End of the Year participants' responses to "Engaging my students in learning science through inquiry has _____ their interest in learning science." The possible responses included "greatly decreased," "decreased," "not changed," "increased," and "greatly increased." N=7 Bloomfield teachers (5teachers did not submit an End-of-Year Assessment).

Bloomfield Teacher Participant Overall Perceptions of Impact of the RIP Program

Confidence in and frequency of using scientific inquiry as an instructional tool

Teachers reported being between "a little more" and "much more confident" in conducting a scientific investigation with students at the end of the first year of implementation compared to before participating in the RIP program (Figure 25, below). This confidence is reflected in the unanimity of participants who reported an increased frequency in which they used scientific inquiry in the classroom since participating in the RIP Program. (Figure 26, below).

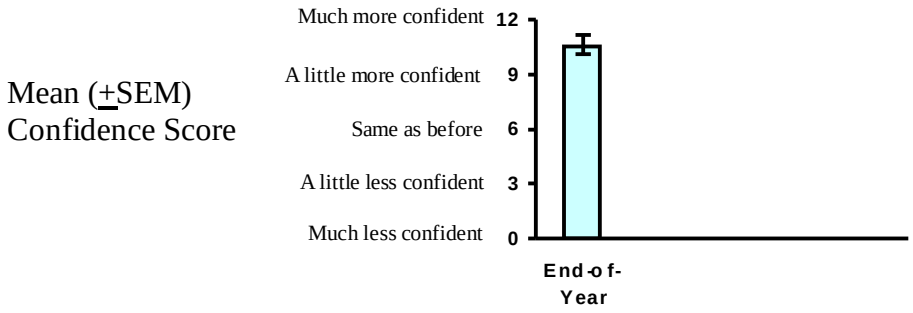


Figure 25. Self-reported confidence levels in implementing scientific inquiry as an instructional tool. End-of-Year participants' responses to "How confident are you now, compared with before you participated in this program and implemented the RIP into your classroom, in conducting a scientific inquiry with your students?" The response scale for the confidence items included "much less confident" ('0'-value), "a little less confident" ('3'-value), "same as before" ('6'-value), "a little more confident" ('9'-value) and "much more confident" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

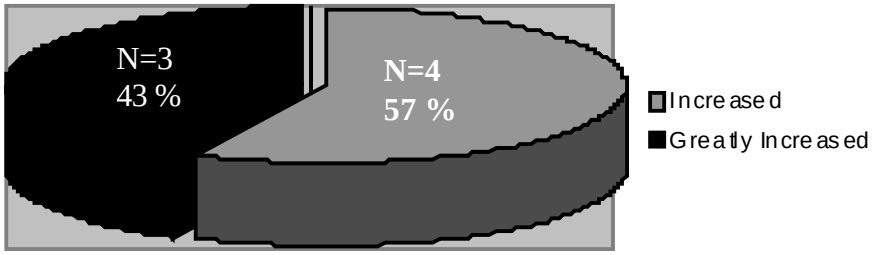


Figure 26. End of the Year participants' responses to "Since participating in this inquiry program, my use of scientific inquiry (RIP) in the classroom has_____." The possible responses included "greatly decreased," "decreased," "remained unchanged," "increased," and "greatly increased." N=7 Bloomfield teachers (5teachers did not submit an End-of-Year Assessment).

Assessing inquiry-based learning: Bloomfield teacher confidence in using and frequency/quality of use of formative assessment with scientific inquiry

At the end of the first year of the RIP Program implementation, teacher participants described themselves as being between "confident" and "very confident" in their ability to assess student understanding and application of scientific inquiry (Figure 27, below). Six of 7 (86%) of the participants strongly or moderately believed that they increased and/or enhanced their use of ongoing assessment in inquiry-based instruction, and attributed this to their participation in the RIP program (Figure 28, below). One participant only "slightly" agreed that they increased or enhanced their formative assessment as a result of their participation in the RIP program.

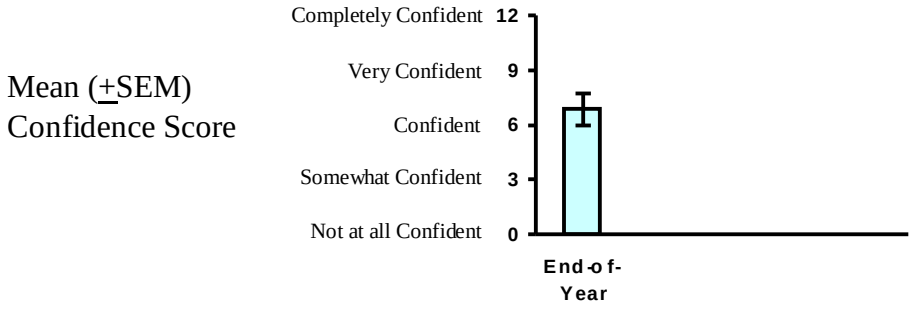


Figure 27. End of the year teacher participant self-reported confidence levels "in assessing your students' understanding and application of the RIP components?" The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

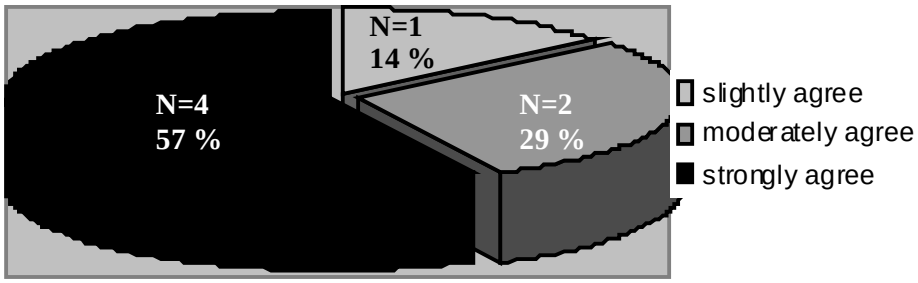


Figure 28. End of the year teacher participant responses to "As a result of my participation in this program, I have increased and/or enhanced my use of ongoing assessment in inquiry-based instruction." The scale for responses included "strongly disagree," "moderately disagree," "slightly disagree," "neither agree nor disagree," and "slightly agree," "moderately agree," and "strongly agree." N=7 Bloomfield teachers (5teachers did not submit an End-of-Year Assessment).

Impact of RIP Program on Bloomfield teacher understanding the scientific inquiry (scientific process) standards and addressing the scientific inquiry benchmarks

According to the teacher participants, the RIP made them "very confident" to "completely confident" both in their knowledge of the scientific inquiry standards that they are responsible for teaching and in their ability to accurately and completely address the scientific inquiry benchmarks (Figures 29 and 30, respectively).

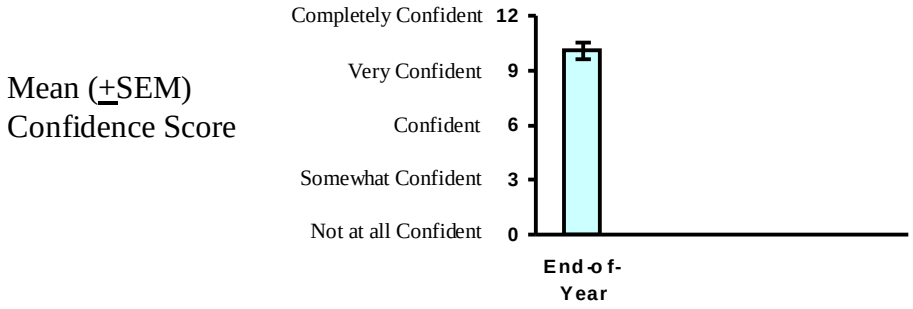


Figure 29. End of the year teacher participant self-reported confidence level response to "Compared with before you used the RIP, how confident do you now feel about your knowledge of the scientific inquiry standards taught?" The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

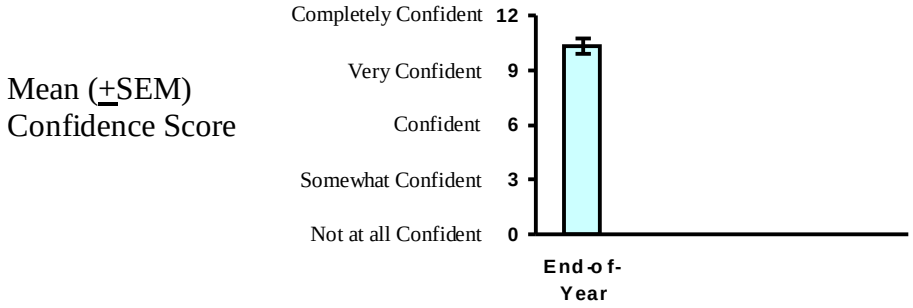
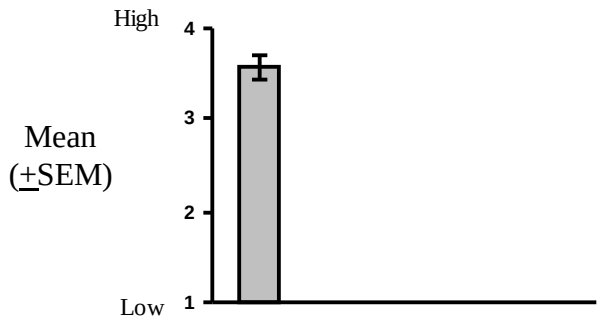


Figure 30. End of the year teacher participant self-reported confidence level response to "Compared with before you used the RIP, how confident do you now feel about your ability to accurately and completely address the scientific inquiry benchmarks?" The response scale for the confidence items included "not at all confident" ('0'-value), "somewhat confident" ('3'-value), "confident" ('6'-value), "very confident" ('9'-value) and "completely confident" ('12'-value). N=7 Bloomfield teachers (5 teachers did not submit an End-of-Year Assessment).

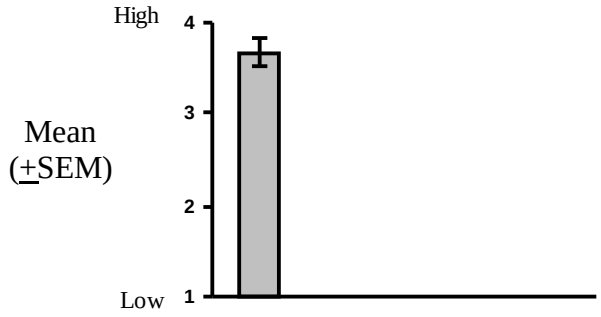
LETQP Initial RIP Training Workshop Evaluation

The training evaluation containing 5 scale items, 3 questions requiring open ended responses, and an optional message from participant to RIP trainer was distributed to the 12 teacher participants at the end of the initial 4-day training workshop. The scale response item summaries are presented below in graphic form, followed by the questionnaire responses, and messages to the presenter.

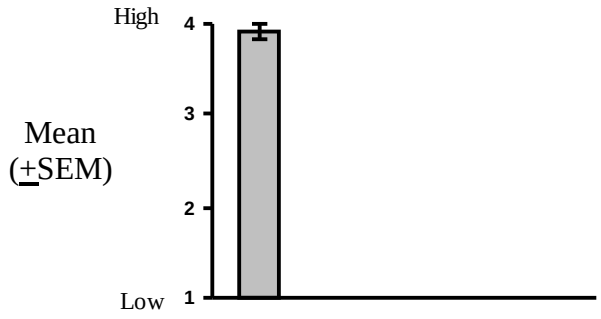
Item 1: Organization (N=12 Teachers)



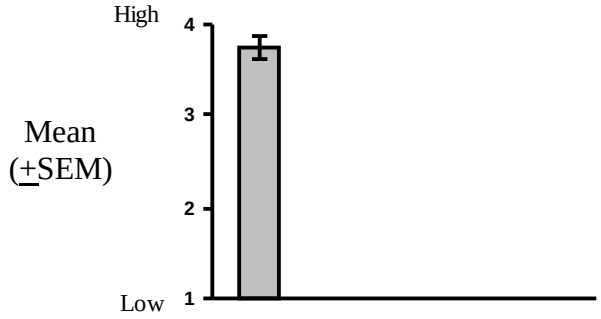
Item 2: Presentation (N=12 Teachers)



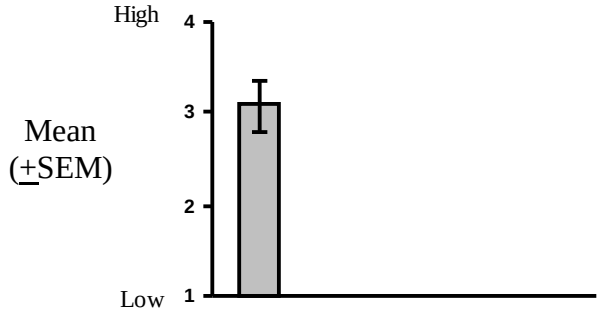
Item 3: Materials (N=12 Teachers)



Item 4: Activities (N=12 Teachers)



Item 5: Pacing (N=12 Teachers)



Question #1: What aspects of the training stimulated new thinking?

- A new way to present information to get students thinking at a higher level.
- The process would engage students and they would become their own teacher.
- Seeing the whole storyboard.
- The option of the students to choose their path to discovery.
- Pretty well the entire training.
- The new way to look at teaching.
- OMG! We should be incorporating scientific inquiry into every grade level and subject. At very least, let's get it into all science courses and into Sped./gifted.
- I need to let go of some of my old-fashioned rote learning and teach differently.
- All aspects made me do a lot of thinking.
- The entire scientific inquiry [process] stimulated new thinking.
- All aspects stimulated new thinking in me. This is different than how I taught for my teaching career. Some of the reasons for learning this way have been in the back of my mind for years.

Question #2: What information/concepts did you find most useful?

- Notebooks & activities.
- The heart rate activity gave an overall continuity.
- When we had to do an inquiry from beginning to end it finally made sense.
- The structure of the RIP program.
- Creating hypotheses, understanding the inquiry method, conducting statistical comparisons.
- The inquiry.
- The true scientific inquiry has little to do with the old scientific process (i.e. labs & elementary/secondary science fairs) as we all learned (badly).
- Three-part hypothesis, Socratic questioning, objective-subjective observations, SEM.
- We did our own inquiry and got immediate feedback from instructor (for help).
- The entire scientific inquiry [process] was useful. There wasn't <u>just</u> one concept that was useful.
- The notebooks correlating with the lecture was very useful. The activities were very helpful to make things more concrete for me.

Question #3: How might you suggest the training be revised or modified?

- Give hand-out examples of other inquiries that have been done.
- Pacing seemed slow at times, but it was definitely thorough.
- More time. Elementary & secondary have separate training.
- Our entire teaching staff should have been trained. If we would have 5 days of training as opposed to 4, we would have had breaks. This was a BIG learning curve.
- Slower pace and more days for training.
- Four days wasn't enough time to study this. I would think this would be better as a summer session to get ready for the new school year. I am grateful that I received it now. The entire staff should have been here for this workshop.
- I'm afraid I'm learning it so fast that I'm going to forget it. For me, a slower pace would be better.

Message to the presenters:

- Very knowledgeable.
- Very rushed on the last day. Would have liked more time to do first RIP.
- I enjoyed this and would have enjoyed this type of learning as a student.
- I am excited to go back and try this in my classroom.
- Thank you!! The training was fabulous!!
- Good job. You are definitely making a difference! Keep it up.
- Great job!!
- Good presenter for a neuroscientist! It sure helped that Dr. Landsman is an ex-teacher.
- I really enjoyed the presentation.
- Thank you. Good, useful information we can use in our classrooms.
- Wow! This is definitely a shift in thinking. How powerful this teaching method could become. Imagine—a country full of critical thinkers. Thank you!
- Thank you for your patience with me. I can see and feel your enthusiasm and I hope I do justice to the process.