Recognizing changes in middle school science teachers' practices

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We work with inservice middle-school and high-school teachers in two high-needs urban school districts in Ohio. Teachers who participate in all components of our program received at least 133 hours of professional development throughout the year. We expect to see pedagogical and instructional changes in teachers' practices as a result of their participation in our program. We report on several ways we quantify changes in teacher practices.

Introduction

There is abundant education research that shows that what an acquaintance referred to as "drive-by professional development" (DBPD; several hours to a day of professional development), the most common form of teacher professional development for the majority of teachers, is ineffectual. [1] In a 2001 review, J. Mestre, referring to DBPD for university faculty finds that "simply giving physics faculty 'tips' in crash workshops on teaching and learning may serve to pique their interest, but it does little to promote effective, or lasting, instructional innovations." [2] Mestre enunciates some central research-based lessons in this review that are relevant to our work discussed in this paper, which we paraphrase here to apply it more broadly to science rather than physics, the original context:

- content and pedagogy should be integrated;
- construction and sense-making of science knowledge is important;

- learning the process of doing science is included;
- opportunities for students to apply their knowledge flexibly across multiple contexts exist;
- students organize content knowledge according to some hierarchy;
- qualitative scientific reasoning is encouraged;
- students use metacognitive strategies; and,
- formative assessment is utilized.

Over the years, there have been many attempts to increase teacher content knowledge and teacher pedagogical content knowledge that meet some or all of Mestre's suggestions. Most of these involve summer workshops for high school teachers. [3] Content professional development for middle school science teachers has been essentially absent save for DBPD. We found only one published study that involved middle school (chemistry) teachers experiencing summer workshops [4] and we found just one study of an extended middle school science teacher professional development experience involving problem solving. [5] Neither of the latter studies involved all aspects of Mestre's lessons. [2]

The Inquiry Model for Professional Action and Content-rich Teaching (IMPACT) program is a professional development (PD) initiative first conceived in 2008 by Principal Investigator Gordon Aubrecht and Science Partner Bill Schmitt meets the standards of Mestre [2] for professional development. The primary goal of IMPACT is to promote increased student achievement by providing students in schools, classified by the Ohio Department of Education (ODE) as "high-needs," the opportunity to benefit from better-prepared teachers – both pedagogically and in terms of increased teacher content knowledge. IMPACT's triadic approach to PD involves three distinct components that, while implemented in unison, are distinct in their objectives: increased teacher-content knowledge support, mainly during summer using materials from the Physics by Inquiry curriculum; [6] the use of common formative assessments (CFAs) with students; and teacher lesson development with an emphasis on research-based inquiry pedagogical approaches. IMPACT's original program, successes and limitations, and attempts at replication in various school districts have been discussed elsewhere. [7]

Our program focuses on research-based inquiry pedagogical approaches and their effect on student achievement in treatment schools. To quantify changes revealed in IMPACTed teachers' pedagogical approaches in the classroom, we rely on various measures, including: staff classroom observations, a curriculum and instruction survey (C&I, see Appendix), and self-reports using selected categories from the Reformed Teacher Observation Protocol (modified RTOP, see Appendix). [8] Participating teachers completed the aforementioned diagnostics throughout the 2013-2015 school years that covered many aspects of IMPACT's approach to PD, including a focus on pedagogical teaching approaches employed in the classroom. This paper discusses the results of these diagnostics. In the past year, we added a control group of teachers to address concerns about extraneous variables, but their responses will be evaluated at the end of the 2015-16 school year and results will be reported in future work.

Methods

Upon entering the IMPACT program, treatment teachers are given several diagnostics that are used to measure the primary components of IMPACT PD: pedagogical approach, scientific reasoning, and content knowledge. For the purposes of this paper, we will only be discussing the diagnostics pertaining to pedagogical approach: Curriculum and Instruction Diagnostic (CID) and Self-Reported RTOP. IMPACT staff also use a different modified version of the Reformed Teacher Observation Protocol during staff observations to quantify perceived changes in teachers' practices. Because we involve teachers in two school districts, some observations were done in each district; our middle school component in a high-needs urban district had just been added, so we concentrated observations there during the first half of the year, while in our pre-existing high school component, we made only six observations, all during the second half of the year.

These assessments are given in a pre/post fashion. For teachers new to IMPACT, the first diagnostic is given to teachers the first day of their involvement with the program – usually in the fall at the first grade-level meeting. The post-diagnostic is given in the spring – usually the last grade-level meeting in May. Those teachers who are returning participants take the test each spring. Their previous spring score is used as a pretest, so to not over-expose the respondents to the items. Staff observations are conducted at random. While there is no "magic number" for the observations each teacher receives, it is estimated that participating teachers receive between four and six unannounced classroom visits by project staff per academic year. All diagnostics are sent to IMPACT's

Exnternal Evaluator for analyses and interpretation. Based on treatment teacher participation in IMPACT, we expect to see gains across all diagnostics.

IMPACT's PD program is a cyclic four-phase process that occurs throughout the academic school year and summer. We estimate that each of our teachers attending all PD will receive more than 133 hours of content/pedagogy exposure and support throughout the calendar year. We have heeded the advice of M. S. Garet et al. [9] in focusing on the "structural features [that] significantly affect teacher learning: (a) the form of the activity (e.g., workshop vs. study group); (b) collective participation of teachers from the same school, grade, or subject; and (c) the duration of the activity." Their research shows that in order to improve professional development programs for in-service teachers, the programs must focus on (1) the duration of the program and (2) collective participation from teachers from the same school, grade, or subject level.

In IMPACT, the majority of these hours focus specifically on a combination of increased teacher content knowledge and pedagogical support with a focus on hands-on-minds-on inquiry-based activities: at least 105 hours of Summer Institute content/pedagogical exposure; 63 hours of grade-level meetings in the form of in-service institutes held during the academic school year; 20-50 hours of Common Formative Assessment (CFA) analysis; 10 or more hours of in-class support throughout the academic year, teacher attendance at professional society meetings, classroom visits by PD staff, and teacher presentations at relevant professional organization meetings. A brief description of how each of the four phases of IMPACT's PD curriculum contributes to changes in middle school science teachers' practices follows.

Summer Institutes

Beginning in June, teachers participate in two weeklong Summer Institute programs where science content aligned to Ohio's Science Standards is taught at a very deep level through inquiry-based approaches, including Physics-By-Inquiry (PbI) lesson exploration and content lessons developed by The Science Center of Inquiry (SCI) and through year-long work by the grade-level teachers.

Teachers work in collaborative learning groups to gain exposure to science content they are required to teach in their classrooms throughout the academic year. Participating teachers experience PbI and SCI curriculum content — through research-based pedagogical approaches — in the role of the student. During these institutes, teachers are exposed to hands-on, minds-on approaches to science instruction that honor student thinking and reasoning. The Principal Investigator, Science Partner, and Education Specialist not only provide content knowledge support to participating teachers, but also model the question-and-answer style inherent to inquiry-based practices that we encourage teachers to take into their own classrooms.

Based on the teachers' own experiences with PbI and SCI curriculum content and pedagogical approaches to science instruction, participating teachers then break into grade-level groups and work together during the summer institutes to collaborate on creating comprehensive multi-week content units for use in their classrooms. The teachers use Ohio's Academic Content Standards as the platform upon which to build their lessons and inquiry-based practices as the mode of content delivery to their students. Teachers begin this process by studying their grade-level content standards and discussing the "big ideas" involved in a specific content band. Based upon their discussions, and with content input from the PI and SP, the teachers delve into the process of creating coherent and sequential content units focusing on student-centered inquiry-based instruction where the primary role of the teacher resides as the facilitator of student learning.

In August, several weeks before the school year begins, the teachers attend a weeklong institute where they have the opportunity to pilot their created lessons with their colleagues at differing grade levels (i.e., 7th grade teachers present their content units to 8th grade teachers with the 8th grade teachers assuming the role of students, and visa versa). The benefits to this approach of lesson development are twofold:

> (1) All teachers are exposed to new science content outside of their grade-band required and tested benchmarks. This not only allows teachers from differing grade levels to explore (often neglected) science content in an in-depth fashion, but also allows for collaboration among 7th and 8th grade teachers as to how the content they teach overlaps and how to prepare students better to make a more seamless transition between grade levels with regard to science content knowledge.

(2) This piloting allows the teachers presenting the content units the opportunity to refine and modify their content units before the lessons are presented in the classroom. Using information gained based upon the presenters' own observations and feedback from their colleagues, combines with content and pedagogical support/modification from project staff, the teachers leave the August Institute with the confidence and pedagogical/content knowledge needed to present and manage the hands-on minds-on inquiry based lessons they have created for use in the classroom.

Grade Level Meetings

The middle-school teachers in our program participate in nine grade level meetings throughout the academic year. During this time, teachers work in both small group and large group settings to refine the curriculum they have created – based upon their increased content knowledge and first-hand experience with inquiry-based learning. Under guidance from project staff, teachers use this time to rewrite curriculum to be presented in the classroom, familiarize themselves with materials to be used in the hands-on inquiry-learning segments, and consider alternative ways of presenting content material to students that will result in increased student understanding.

Common Formative Assessments

Research indicates that use of formative assessment in the classroom, when created collaboratively by teachers across a common grade level for all students in the same course, maximizes the effectiveness of the assessment if the information gathered is used to inform instructional design [10] (Stiggens & Dufour, 2009). The use of Common Formative Assessments (CFAs) is an integral component to IMPACT PD. The teachers involved in the IMPACT program work together to create CFAs to be used across grade-levels in all participating schools in our program. Teachers use the information gained from both pre- and post-CFAs respectively to: 1) identify and address student misconceptions in science content and plan instruction accordingly and 2) reflect upon classroom instructional techniques and identify ways to improve content instruction in the future. A more thorough explanation of the CFAs designed and implemented by

IMPACT staff and teachers can be found in Ref. 11. Teachers also discuss their students' work on CFAs during the grade-level meetings.

In-Class Supports

Throughout the academic year, IMPACT staff provides teacher support in the form of in-class visits. These periodic visits to teachers in their classrooms serve three main functions: (1) expose teachers and students to additional subject content knowledge; (2) provide feedback to specific teacher's instructional approaches; (3) allow the opportunity for staff to provide support for implementing the inquiry-based content lessons created by the teachers into the classroom environment. The IMPACT team also uses this time to complete the modified teacher observation forms to be used as a quantitative measure of teacher growth in our research.

Results

Staff observations

In general, for staff teacher observations, credit is given for student-centered approaches where there is evidence of high levels of student engagement in activities where students are able to think and problem-solve. Staff members filled out a report giving specifics of their observations, which were evaluated and tallied by the external evaluator, who converted the raw numbers into percentages. In each of the three areas, significant improvement is shown from the first half of the school year to the second half.

Teachers participating in IMPACT show a shift from teacher-centered approaches (such as lecturing) to student-centered approaches (such as group projects/experiments), and also more evidence of student engagement. Figures 1 and 2 provide the different between the two periods in which observations were conducted. They are separated into an all-teacher graph (includes the high school teachers), and those only in SWCS, a high-needs urban district. It is believed that changes are more striking in SWCS because it is the first year in which these teachers have participated in the professional development whereas MCS teachers have been involved for multiple years where change may not be as evident.

Figure 1: All Teacher Observations 2013-14 School Year

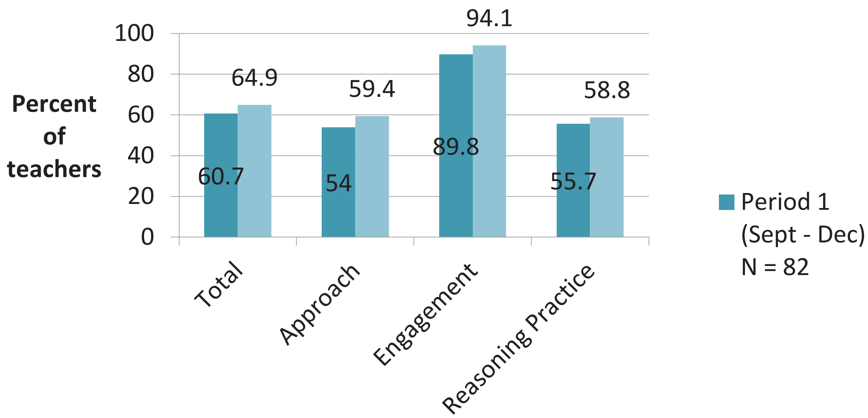
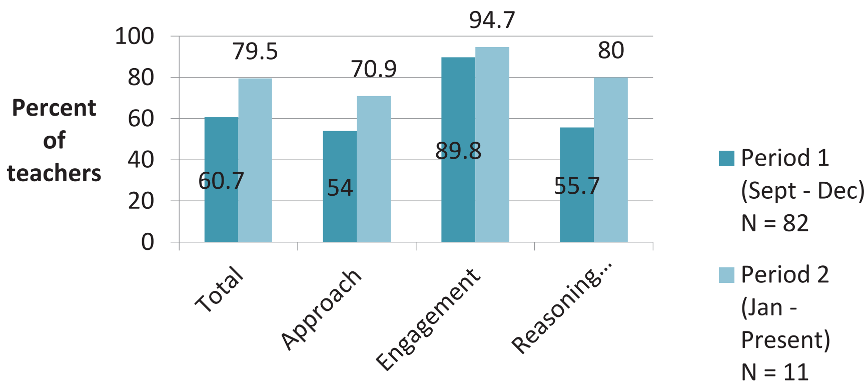


Figure 2: South Western City School Teacher Observations 2013-14 School Year



Curriculum and Instruction diagnostic

The summary of results include of the pre and post average scores for members of the group that took both the pre- and post-CID (there were some teachers who did not take the pre-assessment and others who did not take the post-assessment). The highest possible score is eighty, and the lowest possible score is sixteen. We used the paired t-test results to determine whether or not there is a significant difference between the beginning and the end of the school year. We found a non-statistically significant difference between pre and post testing on the self-reported efficacy items.

The diagnostic, included as an Appendix, is separated into distinct sections: 1) Class instructional time, 2) Individual in-class time, 3) Group in-class time, 4) Homework, 5) Teacher efficacy, and 6) Instructional influences. Teachers select responses that reflect their teaching and beliefs. The following describes how it relates to the inquiry-based professional development. Each item is Likart-like, and in some cases, items are reverse-coded for analysis purposes to reflect responses desired by the IMPACT III instruction. Further analysis gives the difference between the pre and post testing within each section; this aspect is discussed in much more numerical detail in Ref. 12, from which the material in this section is adapted, and not repeated here.

The class instructional time section consists of six items; respondents reported the amount of time their students spent in class on a given activity. They select None (0) through Considerable (50% or more time). See the Appendix for further detail. For analysis, teachers are given a score of one through five corresponding to the task in question. Teachers are given high scores when the reported activity is more student-centered or inquiry-based than teacher-centered, and low scores when opposite. For example, "us[ing] manipulatives, measurement instruments, and data collection devices" is considered inquiry and student-based, and therefore if a respondent reported that students spent considerable time (more than 50%) using manipulatives, the teacher receives a high score of five. With this scoring, the highest possible score for this section is 30, and the lowest possible score is six. Results ranged from 16 to 26 on the pretest and 17 to 27 on the posttest.

Not every teacher took both the pre- and the post-assessment. In reporting results, we use the probability that there is a difference of P, where $P = 1 - p > 0.95$ to assess statistical significance within the group completing both assessments (i.e., the probability that the samples are the same, $p < 0.05$) ascertained from paired t-tests.

When the pre and posttests are compared for all respondents, the average score is nearly identical between the groups. For those who took both the pre and the posttest, however, there is a statistically significant increase ($P = 0.965$) from fall to spring. This group reported that they spent more time on student-centered or inquiry-based activities after the year spent in the IMPACT III program.

The individual class time section probes students' time working by themselves on science exercises, problems or tasks, ranging from None (0) through Considerable (50% or more time). This type of instruction, along with group instruction, was among the two larger changes in instruction as reported by the diagnostic. The maximum possible score is twenty in this section, and while no one reached this ceiling in either pre or post, there were significant increase in scores from the beginning to the end of the school year ($P > 0.999$). Teachers report directing more inquiry-based individual instruction time at the end of the school year as compared to the beginning of the school year.

The group instructional time section examines instructional time in pairs or small groups. The change in group instructional time in class has one of the larger differences (along with individual class time) among the sections of the C&I. Again, the choices ranged from None (0) through Considerable (50% or more time). The maximum possible score in this section is thirty points, and the lowest possible score is six points. After spending a school year in the IMPACT program, teachers report holding more inquiry-based group instructional periods in their classrooms: There is a significant difference ($P > 0.999$) between the pretest averages (ranging from 13 to 27) and the posttest averages (ranging from 17 to 28).

The homework section asks for the percentage of time that students spend on science homework outside of class that teachers expect them to complete computational exercises on a worksheet or from the book, explain reasoning, collect data, and work on an assignment requiring more than one week to complete. This measurement showed no difference from pre to post measurement as to the type of homework participants assign their students.

The self-efficacy section consists of sixteen items, and is the largest portion of the diagnostic. Given that there is a significant amount of focus on increasing teacher content knowledge in the program, it is expected that teacher self-efficacy would rise as the result of increased content knowledge.

In the instructional influences section, participating teachers report similar patterns at the beginning and end of the school year when it comes to instructional influences. In both the fall and the spring, textbooks influenced teaching the least, while district and State standards (as well as preparation of students for the next grade level) are top influencers. Interestingly, district and State test results draw the most negative influence on teaching in both cases. Figures 3 and 4 display the percent of teachers reporting level of influence of each category. Note that these are sorted from largest to smallest percentage of teachers reporting a strong positive influence.

Figure 3: Instructional Influcences (Pre)

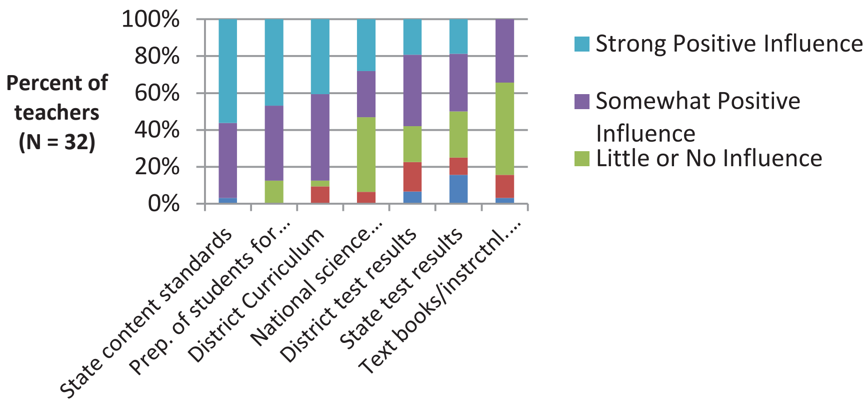
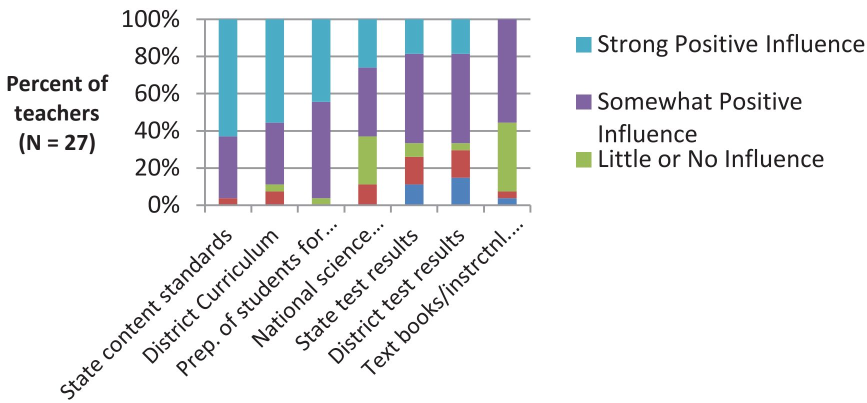


Figure 4: Instructional Influcences (Post)



Reformed Teacher Observation Protocol (teacher self-rating)

The Reformed Teacher Observation Protocol (RTOP) is a measure designed as a tool to evaluate the effects of professional development in K-12 classrooms. IMPACT III teachers completed an abbreviated version, included in the Appendix as a means for comparison for a full evaluation by an outside evaluator. In many ways, this measure duplicates the efforts of the CID and was not intended as anything beyond correlation for the purposes of comparing self-evaluation to that of an unbiased observer.

Like the CID, the RTOP rates the level of inquiry-based and student-centered activity in the classroom. The measure is straightforward in that the higher the score, the more inquiry-based or student-centered the statement. Respondents select a number of zero through four on the diagnostic, and these have been transformed into scores of one through five for analysis purposes in order to eliminate confusion from non-responses. There are seventeen questions total, and therefore the highest possible score is eighty-five, and the lowest possible score is seventeen. Respondents who circle more than one response directly next to one another receive a score in the middle of the two responses. Those with multiple responses not next to one another are scored as a non-response. Scores on the pretest ranged from 38 to 82 (average 59.12 ± 10.12) and on the posttest ranged from 30 to 78.5 (average 61.70 ± 10.85). There is a significant increase in the self-reported inquiry-based activities from pre- to post-testing: The paired t-test results for the group of participants that took both the pre and the posttest show a significant difference ($P > 0.955$) with average difference 5.80 ± 2.71.

Limitations

The study presented here focuses on teachers' self-reported views. Many teachers have been observed by a trained RTOP evaluator, and the evaluations are generally significantly lower than teacher self-reports (with two exceptions in which excellent teachers as rated by the trained evaluator score themselves lower than scored by the trained evaluator). Thus, we must be careful not to overemphasize the significance of these results. In addition, because we have found that teacher self-evaluation tends to produce higher scores than those given by trained evaluators and because these scores do not appear to correlate with the scores of the trained evaluators, [13] we are discontinuing the self-evaluation this current year.

As mentioned above, it is desirable to have a control group to which to compare, and we have added a group of control teachers for the middle school teachers, teachers in the sole middle school in the district that is not participating in the program. This should help alleviate some concerns about extraneous variables. The district student mix is roughly similar from school to school. However, there is a different drawback—the treatment group is about 30 teachers and the control group is only 10 teachers. This measure will help somewhat, but we are attempting to identify a comparison group of similar size to the treatment group in IMPACT in other districts, without success so far.

Conclusions

We have shown that the IMPACT III program is perceived by teachers to have had a significant effect on their modes of teaching. The changes have occurred in the directions anticipated by the staff in creating the IMPACT program, as we had predicted.

In other published papers, [7, 11-13] we have indicated other aspects of the IMPACT program that have made differences to students. Because this paper focuses on the teachers' perceptions of the IMPACT program, we have given no details here. However, for context, the data show that middle school students in the original cohort (now no longer in the program, replaced by the SWCS middle school teachers to test IMPACT's replicability) began far below state requirements on the 8th grade achievement test in science and over the time the teachers were in the program scored closer and closer to state expectations (while remaining still below 75%; the student cores of proficient or above improved from 38% pre-treatment to 58% at termination of teachers' involvement five years later). In contrast, 5th graders science achievement tests diverged more from state expectations over time.

In addition, when the first cohort of middle school students who were exposed to teachers in the IMPACT program took Ohio's graduation test, scores in science jumped significantly upward and remained higher consistently. The average proportion of high school student taking the Ohio Graduation Test (OGT) for the first time and passing was 53.7% ± 1.8% prior to students treated by teachers in IMPACT and rose to 63.02% ± 2.7% afterward. Thus, the science OGT score increased by 8.3% ± 3.3%, or 2.5 standard deviations. This is a huge gain.

These student outcomes support the teacher perceptions expressed through the data presented above that the IMPACT program has affected their teaching in ways that affect their students' learning positively.

Much work remains to be done, but our hope is that by encouraging and empowering teachers to listen to students, to give their students minds-on experiences, that those students will be better able to reason in their subsequent schooling and become productive citizens after schooling ends.

Acknowledgements

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Appendix

Name______________________

Date_______________

Science Curriculum and Instruction Diagnostic

1. What grade level did you teach in the current school year?

2. How many years have you been teaching (excluding the current school year)?

3. How many <u>days</u> per month do you teach science?

4. What is the approximate duration of time spent on a science lesson in one day?

5. Briefly respond to the questions below.

    a. Describe the typical format for your science lessons.

    b. As far as what guides you in your science teaching, do you use mathematics and science indicators, certain websites, district-provided materials, and/or other sources ?

OVER →

Class Instructional Time

0 - None
1 - Little *(10% or less of instructional time for the school year)*
2 - Some *(11-25 % of instructional time for the school year)*
3 - Moderate *(26-50% of instructional time for the school year)*
4 - Considerable *(50% or more of instructional time for the school year)*

How much of the total science instructional time do students…

		None	**Little** (less than 10%)	**Some** (11-25%)	**Moderate** (26-49%)	**Considerable** (50% or more)	
6.	watch the teacher demonstrate how to do a procedure or solve a problem?	0	1	2	3	4	
7.	take notes from lectures or the textbook?	0	1	2	3	4	
8.	complete *computational exercises or procedures* from a textbook or a worksheet?	0	1	2	3	4	
9.	use manipulatives, measurement instruments, and data collection devices?	0	1	2	3	4	
10.	work *in pairs or small groups* on science exercises, problems, investigations, or tasks?	0	1	2	3	4	
11.	reflect on their work?	0	1	2	3	4	

Items 6-11 optional comments and/or elaboration of responses:

OVER →

In-Class Individual Student Work

0 - None
1 - Little *(10% or less of individual work time on science exercises, problems or tasks)*
2 - Some *(11-25 % of individual work time on science exercises, problems or tasks)*
3 - Moderate *(26-50% of individual work time on science exercises, problems or tasks)*
4 - Considerable *(50% or more of individual work time on science exercises, problems or tasks)*

When students work individually on science exercises, problems, investigations, or tasks, how much time do they…

		None	**Little** *(less than 10%)*	**Some** *(11-25%)*	**Moderate** *(26-49%)*	**Considerable** *(50% or more)*	
12.	explain their reasoning or thinking in solving a problem?	0	1	2	3	4	
13.	make estimates and/or predictions?	0	1	2	3	4	
14.	work on a problem that takes at least 45 minutes to solve?	0	1	2	3	4	
15.	solve problems from a textbook or worksheet?	0	1	2	3	4	

Items 12-15 optional comments and/or elaboration of responses:

OVER →

In-Class Pairs/Group Student Work

0 - None
1 - Little *(10% or less of instructional time in pairs or small groups)*
2 - Some *(11-25 % of instructional time in pairs or small groups)*
3 - Moderate *(26-50% of instructional time in pairs or small groups)*
4 - Considerable *(50% or more of instructional time in pairs or small groups)*

When students work in pairs or in small groups on science exercises, problems, investigations,
or tasks, how much time do they…

		None	Little (less than 10%)	Some (11-25%)	Moderate (26-49%)	Considerable (50% or more)	
16.	talk about their reasoning or thinking while solving a problem?	0	1	2	3	4	
17.	make estimates and/or predictions?	0	1	2	3	4	
18.	analyze data to make inferences or draw conclusions?	0	1	2	3	4	
19.	work on a problem that takes at least 45 minutes to solve?	0	1	2	3	4	
20.	collect their own data?	0	1	2	3	4	
21.	present their information to others using computers, whiteboards, projectors, etc.?	0	1	2	3	4	

Items 16-21 optional comments and/or elaboration of responses:

OVER →

Instructional Influences

To what degree do each of the following influence your teaching?

		Strong Negative Influence	Somewhat Negative Influence	Little or No Influence	Somewhat Positive Influence	Strong Positive Influence
22.	Your state's curriculum framework or content standards	1	2	3	4	5
23.	Your district's curriculum framework or guidelines	1	2	3	4	5
24.	Textbooks / instructional materials	1	2	3	4	5
25.	State tests or results	1	2	3	4	5
26.	District tests or results	1	2	3	4	5
27.	National science education standards	1	2	3	4	5
28.	Preparation of students for the next grade or level	1	2	3	4	5

Items 22-28 optional comments and/or elaboration of responses:

OVER →

Homework

0 - None
1 - Little *(10% or less of homework time for the school year)*
2 - Some *(11-25 % of homework time for the school year)*
3 - Moderate *(26-50% of homework time for the school year)*
4 - Considerable *(50% or more of homework time for the school year)*

What is the percentage of time that your students spend on science homework outside of class that you expect them to…

		None	**Little** (less than 10%)	**Some** (11-25%)	**Moderate** (26-49%)	**Considerable** (50% or more)	
29.	complete computational exercises from a textbook or worksheet?	0	1	2	3	4	
30.	explain their reasoning or thinking in solving a problem?	0	1	2	3	4	
31.	collect data as part of homework?	0	1	2	3	4	
32.	work on an assignment, report, or project that takes longer than one week to complete?	0	1	2	3	4	

Items 29-32 optional comments and/or elaboration of responses:

OVER →

Efficacy and Beliefs

Please circle the response which best describes you and your beliefs about science teaching.

		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
33.	When a student does better than usual in science, it is often because the teacher exerted extra effort.	1	2	3	4	5
34.	Even if I try very hard, I can't teach science as well as most other subjects.	1	2	3	4	5
35.	When the science grades improve, it is often due to their teacher having found a more effective approach.	1	2	3	4	5
36.	I know how to teach science concepts effectively.	1	2	3	4	5
37.	If students are underachieving in science, it is most likely due to ineffective teaching.	1	2	3	4	5
38.	The inadequacy of a student's science background can be overcome by good teaching.	1	2	3	4	5
39.	I understand science concepts well enough to be effective in teaching the concepts addressed at my grade level.	1	2	3	4	5
40.	The teacher is generally responsible for the achievement of students in science.	1	2	3	4	5

Items 33-40 optional comments and/or elaboration of responses:

OVER →

Efficacy and Beliefs (Cont'd)

		Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
41.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	1	2	3	4	5
42.	I find it difficult to use manipulatives to explain to students why / how science works.	1	2	3	4	5
43.	I am typically be able to discuss students' questions about science with them.	1	2	3	4	5
44.	I have the necessary skills to teach science.	1	2	3	4	5
45.	Given a choice, I will not invite the principal to evaluate my science teaching.	1	2	3	4	5
46.	When a student has difficulty understanding a science concept, I usually know how to help the student understand it better.	1	2	3	4	5
47.	When teaching science, I typically welcome student questions.	1	2	3	4	5
48.	I do not know what to do to engage students with science.	1	2	3	4	5

Items 41-48 optional comments and/or elaboration of responses:

Thank you!

NAME: ______________________________ DATE: ________________

DIRECTIONS: The 17 statements below are from the Reformed Teaching Observation Protocol. Please read each statement, then put the cursor in the box under the statement and write an answer to this question: "What does this statement mean?" Then, shade the box (little paint can icon) of the number to the right assessing the how descriptive the statement is about how you currently teach: 0 = Does not occur, 4 = Very descriptive.

1. The instructional strategies and activities respect students' prior knowledge and the preconceptions inherent therein.					
	0	1	2	3	4
2. Lessons are designed to engage students as members of a learning community.					
	0	1	2	3	4
3. In lessons, student exploration precedes formal presentation.					
	0	1	2	3	4
4. Lessons encourage students to seek and value alternative modes of investigation or of problem solving.					
	0	1	2	3	4
5. The focus and direction of lessons are often determined by ideas originating with students.					
	0	1	2	3	4
6. Lessons promote strongly coherent conceptual understanding.					
	0	1	2	3	4
7. Elements of abstraction (i.e., symbolic representations, theory building) are encouraged when it is important to do so.					
	0	1	2	3	4
8. Connections with other content disciplines and/or real world phenomena are explored and valued.					
	0	1	2	3	4
9. Students make predictions, estimations and/or hypotheses and devise means for testing them.					
	0	1	2	3	4

10. Students are actively engaged in thought-provoking activity that often involve the critical assessment of procedures.					
	0	1	2	3	4
11. Students are reflective about their learning.					
	0	1	2	3	4
12. Intellectual rigor, constructive criticism, and the challenging of ideas are valued.					
	0	1	2	3	4
13. Students are involved in the communication of their ideas to others using a variety of means and media.					
	0	1	2	3	4
14. The teacher's questions trigger divergent modes of thinking.					
	0	1	2	3	4
15. Student questions and comments often determine the focus and direction of classroom discourse.					
	0	1	2	3	4
16. Students are encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.					
	0	1	2	3	4
17. The teacher acts as a resource person, working to support and enhance student investigations.					
	0	1	2	3	4