Indiana Science Initiative Update: Integrating Formative Assessment to Support Science Learning – TERC Evaluation Report

October 2014

The I-STEM vision is for Indiana to be a national leader in student achievement and to demonstratively improve college and career readiness in the STEM disciplines.

Indiana Science Initiative

Integrating Formative Assessment to Support Science Learning

Final Evaluation Report

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Improving education through evaluation

Indiana Science Initiative Evaluation Report:
Professional Development and Implementation of Formative Assessment Strategies

Since 2010, the Indiana Science Initiative (ISI) has worked with teachers across the state. ISI has provided science kit curricula and has trained teachers in guided inquiry instructional approaches and a science notebooking process to support student reasoning while strengthening literacy skills. Building on this foundation, ISI added a formative assessment component during the 2013-14 academic year, enabling teachers to better evaluate student understanding and to address ongoing challenges and misconceptions. Formative assessment also allowed teachers to extend science learning experiences, further enriching classroom instruction.

Description of Professional Development on Formative Assessment
From June to August 2013, ISI training for approximately 700 teachers was conducted at seven sites. The professional development topics varied slightly by site, but usually included one or more of the following: examining the ELA Common Core State Standards and developing literacy strategies in science that aligned to them, working on FOSS benchmark assessments, extending science learning into mathematics with mathematics extensions, developing supplementary science resources, and preparing to use science kits in the classroom.

The first day of training was consistent across all sites, however, and focused on formative assessment. Teachers learned how to examine evidence for student learning in science notebooks, provide feedback to students, and build upon initial lessons as needed. Continuing ISI teachers had received professional development (PD) about science notebooking in prior years and the formative assessment work extended this instructional process.

During the formative assessment training, teachers:
- analyzed video of ISI classroom investigations and reviewed associated guiding questions and lesson plans to increase their skill in identifying evidence of student learning. They also reflected on teacher behaviors in response to students.
- coded student notebook samples using a three color protocol (red, yellow, green) to indicate student readiness to proceed to the next lesson;
- practiced providing feedback within student notebooks on post-it notes;
- identified Next Step Strategies to re-engage students in learning concepts/information/skills if required based on notebook analysis.

Although developing video and materials for this formative assessment training required substantial work by I-STEM staff, it offered opportunities for teachers to reinvest in the notebooking process by making it more useful. As a result, evaluation data are being collected on both the training itself as well as teacher implementation efforts during the 2013-14 academic year.

Trainer Feedback about Professional Development Sessions
Of the 44 trainers who conducted professional development, 39 responded to a survey. They provided their perceptions of teacher engagement and learning as well as the success of the formative assessment day-long session.

Description of Trainers: Most of the trainers were very experienced, having facilitated ISI trainings for multiple summers; 56% (22) had done this for three summers, 23% (9) for two summers, and four trainers mentioned that they had participated in this initiative since the beginning of the pilot program four years ago. The remaining four mentioned that this was their first summer as a trainer. Over half of these trainers (20) were currently involved in an MSP project as well.

Survey respondents represented all seven training sites with nine each from Evansville and South Bend, eight from Richmond, six from Indianapolis, five from Avon, and four each from Logansport and Marion. Often, trainers provided training in their home district, sometimes joined by trainers from other districts. Six of the trainers conducted trainings at two different sites.

In the 2013-2014 academic year the vast majority of the trainers (26) would return to the classroom to work as a teacher, using ISI science kits and notebooking. Six trainers would work as a school or district coach/ mentor, four trainers would be simultaneously working as a teachers and coaches/mentors. Two trainers would be retired and one trainer explained that she would be returning to work as a teacher but she did not have an ISI kit.

Table 1: Role of trainers during the 2013-14 academic year

Work as a teacher using science notebooking and the kits	Work as a school or district science coach/mentor	Work as a teacher & coach	Retired
67% (26)	15% (6)	10% (4)	5% (2)

The majority of the 36 trainers returning to work as a teacher or coach/mentor in the fall reported that they would be working at the elementary level, with the largest percentage in second and third grade. Table 2 below, provides a grade level distribution of trainers.\

Table 2: Teaching/coaching grade level(s) in 2013-14

Grade K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Not applicable
21%(8)	18%(7)	28%(11)	33%(13)	23%(9)	13%(5)	15%(6)	5%(2)	8%(3)	10%(4)

Professional Development Participation by Grade Level: As seen in the Table 3 below, the majority of sites had a higher level of participation from lower grade teachers (Kindergarten to fourth grade) when compared to the upper grades (fifth through eighth grade). Indianapolis was the only site that trained teachers for all grade levels from Kindergarten through eighth grade. Evansville and South Bend nearly covered all grade levels except for grades four and five respectively. The site with the lowest participation from different grade levels was Marion, which only had teachers from first, second, and fourth grade. What was consistent across all sites, except for Marion, was participation from teachers who taught kindergarten through third grade.
It should be noted that some trainers worked with combined grade level teachers. Two trainers mentioned that they worked with kindergarten combined with first grade and three trainers mentioned working with grades six, seven, and eight combined.

Table 3: Training by grade level at each site

SITE	Trainers per site	K	1	2	3	4	5	6	7	8
LOGANSPORT	4	1	1	1	1	0	0	0	0	0
MARION	4	0	1	2	0	1	0	0	0	0
AVON	5	1	1	1	1	1	0	0	0	0
RICHMOND	8	2	1	1	1	2	1	1	0	0
EVANSVILLE	9	1	1	1	2	1	0	2	2	1
SOUTH BEND	9	2	2	1	1	0	1	2	1	1
INDIANAPOLIS	6	1	1	1	1	1	1	1	1	1
PERCENTAGE		15	15	15	13	11	6	11	8	6
GRAND TOTAL	45	8	8	8	7	6	3	6	4	3

Two Marion trainers described lack of teacher participation and the associated challenges. In response to the question about what grade the teacher worked with on day one, one trainer explained that she was scheduled to work with the fifth and third grade teachers but finally on the day of the training she unexpectedly had to work with second grade teachers with no prior preparation to work with this grade level. *"I was to train on fifth, that got cancelled due to lack of teachers. Then I was to train third but no one showed up. I assisted with second on day 1!"*

Findings about Formative Assessment Training:

Almost all survey questions asked the trainers to rate the level of success using a seven-point scale with the lowest level of success being *1: not at all*, the mid-level of success being *4: moderately*, and a high level of success being *7: a great deal*. In order to simplify reporting the results of the data, the response categories were collapsed in to low (1-2), moderate (3-5), and high (6-7). Overall, the trainers perceived the teachers as being engaged by and learning from the formative assessment PD activities provided. Below, we present aggregated trainer feedback about PD in three categories: 1) activities that were successful with minor variation; 2) activities that were successful but with greater variation; and 3) activities that were only moderately successful. For each of these categories, we provide descriptive data to show site variation.

1) Formative assessment training components that were successful with minor variation:
- The videos were found to be very useful for helping teachers identify evidence of student learning and reflect on teacher behavior.
- Teachers learned to use coding activities (green, yellow, red) to score notebooks and identify student learning needs.
- Teachers learned that science notebooks could be effectively used as a tool for formative assessment.
- Teachers learned a lot about steps they can take to assess student learning in new ways.

Descriptive details: Using the videos during the training was considered to be very effective. As observed in table four, more than 70% of the trainers at all of the sites agreed that *using the*

videos to help teachers identify evidence of student learning and for *helping teachers identify and reflect on teacher behavior* was successful among teachers.

The other questions in Table 4 had over 70% of trainers that thought the training components were very helpful in the aggregate. However, for each of these questions, there were one or two sites that gave a moderate rating about half of the time, as shown in the last column.

Table 4: Questions where overall there was a high level of agreement that the formative assessment training was successful, but with minor variation at some sites

Survey Questions	High	Moderate	Low	Sites where half selected moderate
To what extent did videos help teachers identify evidence of student learning?	82% (37)	18% (8)	0% (0)	none
To what extent did videos help teachers identify and reflect on teacher behavior?	80% (36)	20% (9)	0% (0)	none
To what extent did coding activities (green, yellow, red) help teachers to score/code notebook samples to identify student learning needs?	71% (32)	29% (13)	0% (0)	Marion 50% Indianapolis 50%
To what extent did teachers learn that science notebooks can be an effective formative assessment tool?	73% (33)	27% (12)	0% (0)	South Bend 56%
To what extent did teachers learn steps to assess student learning in a new way?	69% (31)	31% (14)	0% (0)	Indianapolis 50% Logansport 50%

2) Formative assessment training components that were successful overall but with more variation by site:
- Teachers learned how to use the three-color coding protocol.
- Teachers discussed their own strategies for running meaning making conferences and/or using science notebooks.
- Teachers asked for suggestions about challenges they were having with the notebook process.
- Teachers reflected on their own teaching.
- Teachers learned another approach for giving feedback to students.

Descriptive details: Table 5 below displays the questions in which, overall, most trainers agreed that different aspects of the formative assessment training were highly successful. As one trainer explained, "*Teachers that had been in the program before said that they were glad to have training that covered assessment and next step strategies.*"

However when analyzed by site, some had trainers who gave moderate ratings from 50% to 75% of the time. Site variance is shown in the last column of Table 5 to provide an accurate picture of trainers experience in the aggregate as well as differences by site.

Table 5: Components with high agreement but with more variation at some sites

Survey Questions	High	Moderate	Low	Sites where 50% to 75% selected moderate
To what extent did coding activities (green, yellow, red) help teachers to learn about using the three color protocol in general?	69% (31)	31% (14)	0% (0)	Marion 75% Indianapolis 50% Logansport 50%
To what extent did teachers discuss their own strategies for running an effective meaning making conference or using science notebooks?	53% (24)	42% (19)	4% (2)	Evansville 67% Logansport 75% Marion 50%
To what extent did teachers ask for suggestions regarding specific challenges they were having with the notebook process?	56% (25)	42% (19)	2% (1)	Logansport 75% South Bend 67% Marion 50%
To what extent did teachers reflect on their own teaching?	58% (26)	38% (17)	4% (2)	South Bend 56% Marion 50% Richmond 50%
To what extent did teachers learn another approach to giving feedback to students?	67% (30)	33% (15)	0% (0)	South Bend 67% Logansport 50% Richmond 50%

Some of the following comments explain site-specific challenges related to the aforementioned components and impacted the training. For instance, some of the trainers felt that it was difficult to teach the formative assessment strategies in situations where many teachers were new and did not have prior experience:

> *...we helped new teachers understand the notebooking process…We did have to do mini lessons on past years' training because we had new teachers to kits and notebooking.*

> *This specific training was difficult to follow the specific lesson plan because of the amount of new teachers. Teachers were not able to reflect on their Making Meaning conferences or make connections to things we were talking about because they haven't taught science using the ISI method.*

Some of the sites faced unique challenges. Marion was one site that appeared to have challenges due to low participation and disorganization, which was explained by the following comments made by two separate trainers:

> *Lack of teachers to participate in the training! I did the fifth grade training…at Purdue, then met with the teacher who was to do third but was going to be out of the country and did additional preparation for third, then got there and had no third grade teachers to train. I did stay and helped/participated with second but had no prior knowledge of the video, etc. for second.*

> *I don't know how helpful this in-service was for fourth grade teachers. There were 5 teachers the first day and the only teacher who showed up the second day didn't teach science. She only stayed until 10:30 or so.*

3) Formative assessment training components that were moderately successful but with variation by site:
- The guiding question and the teacher lesson plan were useful to teachers when used in conjunction with the video.
- The next step activities helped teachers review and discuss strategies that were in the kit's teacher's guide.
- Teachers learned specific ways to extend instruction when students were confused.

Descriptive details: As seen below in Table 6, over 50% of trainers in the aggregate thought that work on Next Step Strategies and Giving Feedback via Post-it notes were *moderately* helpful to teachers. At the site level, however, there was a fairly even split between those who gave this moderate rating and those who rated these two components highly. In contrast, the Evansville trainers thought all of the Next Step activities were *very* helpful for teachers. One trainer from Evansville commented: *"Teachers that had been in the program before said that they were glad to have training that covered assessment and next step strategies."*

Table 6: Mostly moderate agreement across all sites

Survey Questions	High	Moderate	Low	Sites where majority chose high
To what extent did activities allow teachers to review and discuss Next Step strategies that were in the kit's teacher's guide?	42% (19)	56% (25)	2% (1)	Indianapolis 50% Evansville 78%
To what extent did activities allow teachers to practice giving feedback via post-it notes?	47% (21)	51% (23)	2% (1)	Avon 60% Evansville 67% Indianapolis 50% Marion 50% Richmond 50%
To what extent did teachers learn specific ways to extend instruction when students remain confused about science ideas?	51% (23)	47% (21)	2% (1)	Avon 60% Evansville 89% Richmond 63%
How helpful were the guiding questions and teacher lesson plan when used in conjunction with the video?	31% (14)	56% (25)	13% (6)	

In regards to teachers learning *specific ways to extend instruction* the majority of trainers (51%) said that *teachers learned "a great deal."* However, only Avon, Evansville, and Richmond (the last two being the largest sites), had a majority that thought teachers learned "a great deal" of ways for extending instruction. Most of the trainers at the other four sites thought that teachers learned a moderate amount. A trainer explained why it was sometimes difficult for teachers to learn how to extend instruction:

"None of the teachers I trained on day one had done science notebooking training before and [only] one 1 teacher had taught some of the kits. It was hard to "extend" understanding because I had to first show them the notebooking."

Lastly, trainers were asked *how helpful the guiding questions and teacher lesson plan were when used in conjunction with the video*. One of the trainers commented about why it was helpful to use the lesson plans.*" Having the opportunity to make specific lesson plans using the framework lesson plan provided was helpful and helped us to use what was provided within the kit and add other resources."*

While the use of lesson plans and video was a successful PD approach overall, the following comment may explain why more trainers did not say it was "extremely successful." *"Even though this was the 3rd year for the adoption, out of maybe a dozen people, we had one in the group that had been with us the last few years. All others had little or no experience with notebooking. So, for those, the assessment info was advanced and they had many questions about notebook basics."*

Other Challenges and Benefits of the training: At the end of the survey all of the trainers were asked to report on any additional successes and/or challenges related to the training. Out of 45 completed surveys, only 17 (37%) included responses to this question. Eleven responses mentioned challenges and another 11 mentioned successes. Some of these responses were quoted earlier in this report to provide context to the survey results.

Challenges: As described earlier, the key challenges that were mentioned by trainers were lack of participation and the lack of familiarity with ISI. This second challenge was most likely a major factor that determined the success of the training. The survey questions that either had a "moderate" or a "very successful but with variation by site" response, were typically in response to the more sophisticated components of formative assessment. Thus, it was difficult for teachers to learn or discuss these strategies if they had never taught Science or worked in the past with the ISI curriculum. As the following quote further explains, a high level of teacher turnover or "fluidity of faculty" was a major barrier for teachers to take full advantage of the training, regardless of how well it was taught.

> *"I ran into a significant % of the group who had no training for the use of the kits, so they had cherry-picked random lessons during the previous year. South Bend has a lot of fluidity of faculty, so they don't know from spring to fall what grade level they will be teaching. We spent a lot of time going back to basics of the ISI program as well as doing the day 1 training for this year."*

Successes: Despite the challenges of familiarity with ISI and participation levels, the formative assessment training was considered successful by most trainers. Notably, few trainers gave any of the PD components low ratings, and many provided comments (included earlier in this report) that the strategies taught were well received. Moreover, the trainers remarked on the benefits that went beyond the specific assessment components of this PD. One major benefit, mentioned in nine of the surveys, was the discussions and interactions among teachers that resulted from the training. These interactions sometimes led to other added benefits such as the use of technology to promote further collaboration among teachers. As one trainer explained, *"One of the biggest successes from the training was the result of teachers networking and the continued exchange of*

ideas and lessons through Drop box, Google Docs, etc. I feel these teachers will continue to communicate with each other throughout the school year.”

Another added benefit of these discussions was how it resulted in teachers and trainers making connections between the ISI curriculum and other subjects or types of assessment. One trainer mentioned incorporating the Science Making Meaning with the TAP rubric. Another trainer commented on how teachers began to see connections with other subjects “*Conversation brought about through categorizing the Common Core Standards was great and a made a big impression on the overlapping of Science with other subjects taught during the day.”*

Although having varying levels of experience was often a challenge in teaching the formative assessment strategies to new teachers, in some instances it was a benefit since it gave more experienced teachers an opportunity to deepen their understanding by having to re-teach what they had previously learned to the less experienced teachers. One trainer explained,*“…The more experienced teachers in the group were awesome in helping new teachers and thought it was helpful to go over some process from past trainings also.”* Another trainer mentioned how returning teachers still felt challenged and they were able to continue building on what they had learned previously about the assessment strategies.

Some of the discussions and interactions between teachers also had more practical benefits such as planning how they would use the curriculum by developing lesson plans. “*Having the opportunity to make specific lesson plans using the framework lesson plan provided was helpful and helped us to use what was provided within the kit and add other resources*.” Another participating teacher reported as a result of the “*presentation on TRIAD Summarizing--a reading strategy for science text*” his/her team was able to plan how they would use the first four chapters in Science.

Finally the opportunity for teachers to discuss or reflect on their teaching with others was a benefit in itself. These exchanges seemed to reenergize teachers’ enthusiasm. A couple of trainers explained, “*Teachers gained the most knowledge when they were able to reflect on their teaching with others. Wonderful ideas were shared and questions answered.”*

Implementation of the Formative Assessment Process in Classrooms

After giving teachers the first semester of the academic year to incorporate formative assessment (FA) strategies, we collected data about the ways in which they were using and customizing them within their classrooms. We were particularly interested in learning about the ways in which the FA process augmented ISI kit instruction and science notebooking as well as successes and challenges during the first year of implementation.

The findings from this report represent the experiences and opinions of teachers who participated in ***focus groups, follow-up individual interviews, and a survey***. Twenty-five teachers from Avon, Evansville, South Bend, and Richmond district participated in the focus groups. Five of these 25 teachers also participated in an in-depth follow-up interview. Eleven teachers from Avon and Logansport district provided additional feedback via a survey. It is important to note

that each school district has a unique set of circumstances; some had more exposure to ISI and other types of professional development (PD) while others had less. The districts also varied by the grade levels that were represented which may account for the variability in how formative assessment strategies were used.

Study Design and Methods

To build upon survey findings from ISI Trainers regarding their formative assessment professional development sessions, TERC initiated a plan to collect data from ISI teachers. The I-STEM Science Program Manager, Jennifer Hicks, consulted with district coaches who identified good candidates to participate in focus groups, based on the extent to which they were implementing some of the formative assessment strategies from the 2013 ISI summer training.

Focus groups: In February 2014, teachers from four school districts in Indiana were invited to participate in focus groups to explore the extent to which teachers were implementing formative assessment strategies that they had learned from the Summer 2013 ISI Training. The table below breaks down the number of teachers by district that participated in each focus group.

Table 7: Focus group participants

District	Grade levels represented	No. of Teachers
Avon	K,1,3,4	5
Evansville	2,3,4,7,8	8 (1 person was a trainer)
Richmond	3-8	6
South Bend	2,3,4	6+1 science facilitator

Once teachers agreed to participate, Jennifer Hicks coordinated scheduling and conducted the focus groups in each of the four districts. TERC evaluators, Audrey Martinez-Gudapakkam and Karen Mutch-Jones participated in 3 of the 4 focus groups via Adobe connect, listening and, in some instances, asking additional questions at the end of the focus group. In advance of the interview, TERC evaluators requested that the teachers bring with them several student science notebooks that included evidence of formative assessment activity. A stipend was provided to each participating teacher to cover after-school time.

TERC developed a *focus group protocol* based on research questions that matched the types of formative assessment strategies taught at the 2013 ISI summer training, and the information gathered from the trainer survey. The main questions addressed in the focus group protocol were the following:
1. What teachers learned from the summer PD and how they are implementing formative assessment strategies in their science classrooms;
2. How teachers identify ongoing student needs, confusion, etc. (with examples from notebooks);
3. The changes teachers make to lessons as a result (with examples from notebook entries that follow the teaching of a revised lesson);
4. Teacher perceptions of the influence of formative assessment on their instruction.

Following each focus group interview, Jennifer Hicks sent a link to a video recording. TERC evaluators used screen flow to convert the links into video files, which were then sent out for transcription. TERC did a preliminary transcript review to identify the types of formative assessment strategies teachers mentioned, including those covered in the ISI summer training as well as others that teachers learned earlier. TERC developed a logic model that was ultimately revised and streamlined. Based on logic model discussions, TERC evaluators generated a codebook to capture data that was elicited by our questions and that emerged from teacher conversation. The codebook went through several iterations so that we could apply codes consistently.

Each of the transcripts were uploaded to Nvivo, a software program for qualitative analysis, and several codes/nodes were created to capture three main types of information. Codes used included:
- Types of formative assessment (FA) and next step (NS) strategies teachers used
- Purpose for why teachers chose to use specific FA and NS strategies
- The impact or benefit that teachers reported in using these FA and NS strategies.

After initial coding, we revised our coding structure by further defining, simplifying, and adding codes. Once this process was completed all of the transcripts were revised according to the updated codebook. *The focus group protocol, logic model, and codebook can be found in Appendices A-C.*

Follow-up Interviews: After completing the analysis of focus group transcripts, specific teachers, chosen based on comments made during the focus group, were identified to participate in individual interviews. Towards the end of May 2014, these teachers were sent e-mails inviting them to participate in a follow-up in-depth interview. A total of 5 teachers agreed to participate. Based on the quality of information that teachers provided during the interview, some of the teachers were asked to provide samples of student notebooks with evidence of formative assessment strategies. Four of these teachers were able to provide sample notebooks and all of the teachers were given a stipend in exchange for participating in the interviews.

Table 8: Follow-up interview participants

District	Grade levels represented	No. of Teachers
Avon	4	1
Richmond	4,5,6	3
South Bend	3	1

The follow-up interview protocol was developed by TERC to identify the types and frequency of formative assessment and Next Step strategies used by teachers. During the process of developing the protocol, Jenny Hicks was consulted for feedback, and revisions were subsequently made to the instrument. In order to ensure teachers could provide concrete examples of how they used these strategies, the interview questions were structured in such a way that teachers could sequentially describe a recent lesson that they had done with students. As teachers described each phase of the lesson they would be prompted to describe any types of formative assessment and/or Next Step strategies that they had used throughout the lesson. During the interview teachers were asked to refer to notebooks that represented three types of

students (struggling, average, or excelling) so that they could describe how use of these strategies varied depending on the student. *The follow-up interview protocol can be found in Appendix D.*

Post-implementation challenges survey: In order to include the perspectives of teachers that did not participate in the focus groups and individual interviews, a survey was also administered. The purpose of this survey was to better understand the challenges teachers faced implementing what they learned from the 2013 ISI Summer training. This survey was sent to 39 teachers from 5 school districts, with 13 teachers completing it (see table below). Only one of the survey participants had previously participated in a focus group and individual interview. In exchange for their participation all of the teachers were sent an Amazon gift card. The survey was developed at TERC in collaboration with Jennifer Hicks. *The survey protocol can be found in Appendix E.*

The main questions that the formative assessment section in the challenges survey addressed were the following:
- Which types and with what frequency were formative assessment and Next Step strategies used during the 2013-2014 school year?
- What were the major challenges or factors that prevented teachers from using these strategies?
- How effective was the 2013 ISI summer training in enabling teachers to use these strategies?

Table 9: Survey participants

District	Grade levels represented	No. of Teachers
Avon	K, 2, 3, 4	4*
Logansport	K - 5	7
Grand Total	n/a	11

Formative Assessment Process: Description of Teacher Implementation and Results
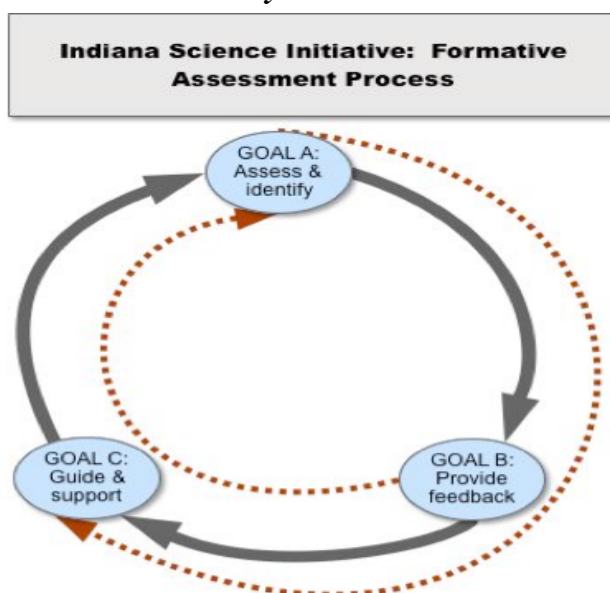
The formative assessment process enables teachers to continually assess student understanding throughout the learning process. By using formative assessment (FA) and Next Step (NS) strategies, teachers can differentiate and modify their instruction to meet student needs in a timely matter. As a result, teachers do not need to wait until final unit assessments to determine what students understand, and they can intervene before it is often too late to provide additional support to students. Such an approach increases the chance that students will perform better by the end of the unit.

As illustrated in Figure 1 and Table 10, three goals comprise the formative assessment process and teachers used multiple strategies to meet these goals. Although a typical formative assessment cycle may involve moving sequentially through goals A, B, and C, the teacher might skip or repeat some of these goals because of the subject matter and/or students needs. For instance, if a teacher assesses students (goal A) and finds that they are excelling, then he/she may decide that providing feedback (goal B) is unnecessary and will skip to providing students with

activities that will further guide and support where students are at (goal C). On the other hand, if students are struggling and the teacher provides feedback to students, the teacher may feel the need to once again assess students to evaluate whether or not the feedback was sufficient in supporting student understanding. One teacher's description shows both the value of formative assessment and the iterative nature of the process.

> *…formative assessment teaches kids that learning is a process, and that you're not necessarily dumb if you're wrong… If kids get to a test and they get an F, then it's the teacher's fault, in my opinion, because you should have never let them get to that point, and not know where they're at. Because if you're assessing them three weeks after the activity that they did— it's too late….That means nothing to them and there's no chance to fix anything.*

Figure 1: The Formative Assessment Process Cycle

Table 10: Types of strategies used for formative assessment process goals

Goal A	Goal B	Goal C
Assess student understanding and/or identify challenges	**Provide feedback to students**	**Guide and support student learning**

• Reviewing key sections in the notebooks
• Color Coding
• exit slips
• Making Meaning conferences to assess students
	• post-it notes to provide feedback
	• verbal feedback
	• color coding to verbally label or categorize
	• color coding with sticker dots or post-it notes
		o Next Step strategies
		  • mini-lessons
		  • line of learning
		  • key points
		  • Reviewing and critiquing anonymous student work
		  • Other Next Step strategies
		o Making Meaning conference

Goal A - Assess student understanding and/or identify challenges: During the focus groups, teachers revealed using a variety of formative assessment strategies to identify student progress and the types of challenges that interfered with student understanding. Some of the strategies teachers used were taught at the last summer 2013 ISI training but there were many others they had learned previously from other non-ISI sources. There were also many instances where teachers modified the ISI formative assessment strategies. The following describes some of the strategies used.

Teachers would assess students by ***reviewing content or sections in the notebooks*** such as: evidence used in student claims, response to the focus question, the "I wonder" statement, charts, tables or drawings, and conclusions. By focusing on key sections, teachers could quickly identify student confusions or misunderstandings without having to read through everything.

> *...some [of] the bonus questions lend themselves to deeper thought. So I don't grade or use the whole thing [notebook] every single lesson. But I usually pick the ones [notebooks] that kind of, towards the end that are summing up what we've done, maybe five days of it. But then this last focus question really has to pull stuff together, so I'll use that one as my, you know, it's not just the facts, this is what we did, kind of thing.*

Although teachers tried to review notebook entries, they often had too many students and too little time, spending a few minutes on each student notebook was prohibitive. The following quotes are examples of how some teachers tried to tackle this issue.

> *what I will do is, as the students are investigating and they're notebooking, then I will go around and see, you know, who has claimed an evidence, and when I do conclusions and we've worked that out together after Making Meaning, I'll look and see what they have, and then I'll make notes, and then I'll pull small groups of kids that I know weren't, I could tell by what they were notebooking they weren't understanding what they were supposed to from the investigation. So then sometimes I'll show like a Bill Nye video and then back off.*

While quickly reviewing notebooks as she walked around the classroom, another teacher put a sticker in notebooks where students had completed their conclusion. This turned out to be a motivator to finish their work.

> *[Stickers] prompted them to make a conclusion before I even said anything, because they looked forward to that…. I put a sticker on anybody who has a complete conclusion…. But it gives me the chance to go around and see everybody's notebook without collecting them [before they] go home.*

Some teachers that didn't have time to review all of the notebooks would select only a random sample of all the notebooks and would focus on key sections:

> *I'll randomly pick them [student notebooks], especially if they're kids that I think may not be on task like they should, or, you know. Some of my lower kids, some of their "I wonders" are the best. But no, I don't spend time reading them all. I wish [I could].*

Although the ISI summer training taught teachers to use ***Color Coding*** to provide feedback to students by marking notebooks with three different colors (red=incorrect, green= accurate, yellow=incomplete). Most teachers found this strategy to be time-consuming. Instead, they used the general idea to sort student work into red, green, and yellow piles. They could then look at the groups that were having difficulty and assess where there were misunderstandings. One teacher explained how using the ISI color coding strategy was helpful:

> *"Yeah, looking at the notebooks, and maybe assessing, you know, formatively with the red, green, and yellow, or even with the post-its, kind of lets you know if you need to do a whole class discussion, or maybe you just need to do a little mini-lesson."*

It should be noted that regardless of whether teachers used color coding as taught or in a modified fashion, many found that just learning about this strategy helped them be more cognizant of student understanding and confusion.

> *So, you know, like you said, I don't go in and I don't make the colors, but it does make me more cognizant of the fact that I need to be looking to make sure that they're understanding.*

Another way teachers would assess student understanding was by using ***Exit Slips*** on which students provided a quick response to a question about that day's lesson. This was a strategy that several teachers from Avon and Richmond teachers reported using prior to the ISI summer training. They explained that it was a faster, easier, and more convenient way to assess student understanding without having to collect all of the notebooks to review student work. One teacher employed a small T-chart as an exit slip to see which students understood the difference between insulators and conductors:

> *[I would have students] do an exit with the little T chart, and so they can list which is which, because that is one of the focus lessons. And so you can quickly see who understands what that insulator is and know what that conductor is. And you can look at that in the notebook as well. But again, for me, it's just easier for them to get it out of there, put it on a post-it and bring it to me with their name on it, and I can just sort those post-its, and then they can hang onto their notebooks instead of collecting them all.*

Many teachers reported using ***Making Meaning Conferences*** to assess students. The main purpose of these conferences is to help students make sense of a science investigation by reviewing, reflecting, articulating, listening, and learning from each other. However while students were sharing their data, claims, or evidence from their notebooks, teachers would be carefully listening and taking notes of what students were saying. They would notice who was talking and who wasn't, since often the more quiet students were struggling. Teachers could also identify students with incomplete notebooks (if they were missing statements or proof of evidence), which students had misconceptions or misunderstandings, and finally what types of support (or Next Steps) different students needed. This strategy was especially helpful if teachers did not have time to review all the student notebooks during the investigation process.

But I also think that the Making Meaning conference itself is formative assessment, and that's probably the most helpful piece to actually hear what the kids are thinking, and they can show you in their notebook there, other than just looking only at the notebook, kind of two-fold.

...because I teach first grade, and you're dealing with kids who...have not developed any kind of internal dialogue anyway. So everything's coming from talking. So I mean in some ways, that makes my job a little bit easier when it comes to Making Meaning, and cause all I have to do is walk around and interact with them, and I'm going to catch... their misconceptions and things like that. So in some ways, that does make my job much easier. But yeah, I mean to me, that, and those kind of mini-lessons and stuff like that are almost an ongoing thing. But it comes out of actually just kind of getting down and dirty and talking to them while they're there physically working at it, before we ever go to a conclusion.

Goal B - Provide feedback to students: During summer training, teachers learned strategies to provide feedback or communicate with students through their notebooks via questions, hints, and suggestions. After teaches had assessed and identified student challenges, providing feedback was especially useful for students that needed minimal guidance to improve their work or for advanced students that would benefit from expanding on or deepening their learning.

Teachers in Evansville, Richmond, and South Bend reported using ***post-it notes to provide feedback*** to students. Some teachers found that using post-its was a less intrusive way to give students an extra clue or redirect them. One South Bend teacher reported that it enabled him to give better and more frequent feedback to students. Students also seemed to benefit from using post-its, since it gave them another way to communicate questions or comments for the teacher. One participant explained that it gave students a sense of pride to use post-its because, "Sometimes they just like to feel, I'm a big kid with office supplies." The quote below further explains how students appreciated the use of post-its.

I've been using the post-its a lot ... to write to kids, because I used to mark all over their pages, and I found that they're more receptive to pulling that post-it off. They like taking that off. And I think that's the way they feel about, in their notebooks too. Like whenever they fix [errors], or whenever they understand the concept, they like the flexibility of pulling the post-it off. And also with the red, yellow and green, I use stickers, and they like taking them off when they're no longer red or yellow.

Other teachers combined the post-it notes with color coding, so that students could easily see if their work was accurate (green), or incomplete (yellow), or incorrect (red) and take steps to improve it, if needed. The following quote from a teacher illustrates this combined approach.

I don't write in their notebooks. I will write on post-it notes and put it in their notebooks. The notebooks are for their writing and their ideas, and not mine. So if I write in their notebooks, normally it's on a post-it note. And I do the red, yellow, green post-it notes. And they understand the different colors, what the different colors mean. And if it's, if they get a red, normally there's a note on there, hey, come see me. We're going to have a

mini-lesson tomorrow in class. And, I do write notes in there. Do I do it every day? I don't.... So I do look at their books probably once a week. But I do use post-it notes, and I use the red, green, yellow post-it notes. And it's kind of cool that they come in, and they're like, yes, I got a green, and who else got a green? And I got a yellow, and the ones who got a red don't really say much. But they're always kind of excited to look into their notebooks and see what color they got.

Not all teachers were complete fans of using a post-it note strategy, as they found it time-consuming to use with large numbers of students. Thus, they employed it in a targeted fashion—using it only when students needed specific and minimal feedback or in conjunction with certain types of lessons, as illustrated by the two examples below.

I would put a post-it note in [a student's notebook] if it was something they could fix, like did you include your date? ...It would be just minor things that I put on post-it notes.

... when I use the post-its...it's more of a knowledge based type of lesson, versus a process or concept base... It's really about what kind of activity, what kind of understanding is it? Is it a process understanding or is it a factual understanding? ...for example, on the moon phase calendar, this student, [has] a whole week missing. I could just put [a post-it] there, [telling him] You need to get data on there so you can see the process. Or how did you go from, you know, a full moon to a waning crescent? Like how did that happen? That type of thing where they could fix it and take it off... Because that's the beauty of a post-it. They can get rid of it and fix it.

Throughout focus group and individual interviews, teachers highlighted the importance of giving **verbal feedback** when reviewing notebooks during class. Some explained that if a good portion of a student's work was not accurate, it would be frustrating for him/her to have everything marked incorrectly. Furthermore, they suggested that oral feedback would be more appropriate when students were grappling with complex "…process or the 'why' types of activities" or challenging concepts.

When it was a concept, I normally did not put [feedback] on a post-it note. I usually talked to them individually, because that would be something that I needed to assess quickly and on the spot, because it would have been something that I had hoped had been done. And we were moving on, so I would call them over and talk to them.

But if there is something that they are truly, truly, truly struggling with, they need to know what they struggled with so they do not forget that concept. ... And this was not an activity where I wanted them to get rid of what they thought of, you know, their misconceptions. So I do use the post-its, but not this activity.

Additionally, some teachers used *Color Coding **language*** as part of their oral feedback to help students understand both the extent and types of improvements needed.

I use the red, yellow, green. And I don't mark in their journals, cause I don't want the one poor kid to have red everywhere. But it comes in the conversation. And because most

of our testing falls under red, yellow, green, my kids really understand that. But then, and that's something I really started doing this year, of having that conversation. Well you're really [off target], this is a red notebook. Here are some suggestions for getting it up.

Goal C - Guide and support student learning: In response to identified challenges, teachers responded with *Next Step Strategies* to meet the unique needs of each student. For struggling students, this might mean clarifying misconceptions or solidifying understanding, whereas for more advanced students it could be extending, deepening, expanding, or connecting new knowledge to other topics, concepts, ideas, content, or disciplines. This is why some teachers refer to Next Step strategies as lesson extensions. After using Next Step strategies, students can review their original work and then make revisions or add to what they have already written in their notebooks. In this way, students, just like scientists, have an opportunity to engage in a reflective process about what they are learning.

The most frequently used ISI Next Step strategy was the ***Mini-Lesson***, during which teachers briefly interact with groups of students to address a specific need. One teacher described how students were confused about what happened to the sun on cloudy days. In response, she inserting a mini-lesson into the day's activities, using cotton balls to demonstrate to students how clouds cover the sun. Through this mini-lesson, she felt students got a better sense that the sun wasn't disappearing and that the Earth was rotating.

The second most popular ISI Next Step strategy teachers mentioned was the ***Line of Learning***. For this, students returned to notebook passages, drew a line under what they previously wrote, and then added the date along with new information that would extend or revise their original thinking. One teacher explained how he would discourage students from erasing what they had previously written in their notebooks.

> *We never erase in our science notebook. And I stress that over and over again, that we don't erase. If you've gained a new knowledge, then that's exactly what we do, the line of learning. We draw a line, and then we write down the new knowledge that we have gained. But we don't erase in our science notebooks.*

Another teacher used the line of learning to help students that were struggling:

> *I think that [line of learning] helps a lot of my lower end, struggling students to be able to come up with the way they want to state their conclusion, and the wording they want to use, by hearing others speak it over and over again, and then by them being able to express it themselves.*

Finally, a teacher used the line of learning approach to help students reflect, change, or build upon initial hypothesis as they begin work on a new topic.

> *I use a line of learning also, except I usually do it before we begin a new kit, just to see where their baseline is, and then at the end of each investigation, is when I include the line of learning. I don't ask them to go back and revise. I want them to leave their original thinking, but I do ask them, when they draw a line and add, that they correct any misunderstanding that they had from the previous. So if they go back and read their line*

of learning, then if they, oh, I used to think, whatever the concept was, but now I know, and I have them kind of update it underneath the line that I just drew, and then add on new concepts that they've learned.

Key points was a third Next Step strategy teachers employed via discussion aimed at eliciting key ideas from students. Words or brief phrases from these points would be recorded on the board so that students could review their responses and/or add new information to answer the question completely. A few teachers realized that this strategy was also very helpful for students who did not have the vocabulary to accurately communicate their understanding. The quote below shows how the "Key points" Next Step strategy was very useful for students that struggled with communication.

> *I like to list the key points, basically so that those that are maybe not as able to express themselves, at least get their thoughts together, and make sure that they're on the right path of writing down their conclusion, that they have those there to go from.*

Reviewing and critiquing anonymous student work was used by some teachers to refine and improve responses for content and literacy. A teacher described how this strategy was typically used:

> *Another strategy that I use is one that I used to use when I was teaching English and writing, and that is to show samples. And after they've written a conclusion, the next day, to show samples. It's nice, cause with the four classes, I can pull samples from other classes and they don't recognize, you know, someone else's writing. And I'll show them an exemplary answer, and they can see that, and like here's a really well written conclusion. Then I'll show them one that's not very good, and they love to pick it apart. They love to pick each other's work apart. And then they can see right away what's missing, and after seeing a couple of those, and they can pick out, after seeing the good one, they can pick what's missing. And I'll tell them, now look at yours, which is what I used to do. We all, you know, when you teach writing you show samples. But that's been a really powerful strategy tool.*

In addition to these four strategies, teachers intentionally took "next steps" in other ways with students. They emphasized the importance of hands-on activities and approaches that they had learned during prior ISI trainings, often modified to respond to specific student needs. Some examples are listed below:
- o *Hands-on activities and FOSS performance assessments*
- o *Additional homework researching topics of personal interest*
- o *Inviting a guest speaker/presenter (e.g., local newscaster)*
- o *Essay writing*
- o *Graphs, diagrams, drawings*
- o *Vocabulary activities*
- o *Videos*
- o *Additional reading*
- o *FOSS foldables/ notebook inserts*
- o *Field trips*

Making Meaning Conferences to Support the Formative Assessment Process

Over the years, ISI training has stressed the importance of "making meaning" from science activities. Most ISI teachers had prior training and experience using ***Making Meaning conferences***, yet frequently, these conferences were skipped as teachers ran out of time following an investigation. Attention to formative assessment helped to illuminate the importance of the conferences—often, they served as a Next Step strategy through which students could review, reflect, articulate ideas, and listen to others. Below, teachers comment on the benefits of making meaning conferences

> *We also do a Making Meaning conference with every investigation, with every lesson within that investigation. It really helps to solidify why we were doing what we are doing, and it helps the kids to have a better understanding of content. So we do Making Meaning conferences with every lesson.*

> *I think what came out of it for me, the thing that came out between the two years is the need for the Making Meaning conferences. We have them at the end of every unit, I want to say, or each lesson, but now when we're doing a lesson that may take two or three days, we make sure that they're doing, that we're meeting together before we close shop, because their responses are much, much better. They're more complete. Their thoughts are well thought out, and more than that, they're also giving more and more supporting evidence.*

Teachers also found creative ways to integrate the use of post-it notes to support students' ability to articulate their thinking. The quote below explains how a formative assessment strategy could enrich the Making Meaning discussions by having students use ***post-it notes*** to write examples from their experiment, which they could later refer to as evidence while discussing their claims during the Making Meaning discussions.

> *I think I've kind of blended how I've used the post-its, where I used find specific examples that mark for your evidence in a book when we're reading. Okay, find examples of this, where I've kind of come back to that…I'll say find examples from the experiment and post it, and put a sticky note on it, so that when we start sharing at the Making Meaning, so when somebody says, "I think that the heavier things, or the smaller things are always lighter," somebody's already ready to go, "not so fast!" …I've kind of blended the science, how I used to use post-its other places, and brought them kind of both together. So we use a lot of post-its.*

Lastly, the Making Meaning Conference provided opportunities for students to combine their knowledge and reach a new understanding as a group.

> *I used some post-its as an exit slip to just kind of see, and that helped me to go back and say, we just kind of sorted them out, like what was in common with these, and we were able to get to it that, at least the metal ones it stuck to, kind of have some common element in them. And we kind of did that through a Making Meaning conference after the lesson.*

Challenges Implementing the Formative Assessment Process

With one exception, teachers who had not participated in either the focus group or the individual interview were surveyed to better understand challenges they faced in implementing the various formative assessment strategies. At the beginning of the survey, teachers were polled about which strategies they used during the 2013-14 school year. As shown in Table 11, mini-lessons and writing key points were used most frequently, while color coding and Line of Learning were used least by respondents.

Table 11: Types of formative assessment strategies used by survey participants. (n=11)

	Never used	A little (1-2 times during school year)	Somewhat (3-4 times during school year)	Used extensively (more than 4 times during school year)
Color coding notebooks to indicate student readiness	6 (55%)	4 (36%)	0 (0%)	1 (9%)
Providing feedback to students with post-it notes	4 (36%)	1 (9%)	5 (45%)	1 (9%)
Mini-lessons	0 (0%)	1 (9%)	4 (36%)	6 (55%)
Line of learning (in notebook)	5 (45%)	1 (9%)	3 (27%)	2 (18%)
Writing key points	3 (27%)	1 (9%)	2 (18%)	5 (45%)

It comes as no surprise that the leading barrier to using formative assessment was lack of time—this is a frequently cited as the root of many instructional difficulties. A few survey participants provided a brief description of how lack of time interfered:

- o *Too many students, not enough time in the day.*
- o *Lack of time to assess all notebooks, all the time.*
- o *I wish there were enough time for this but by the time we do our science experiments/investigations, etc. We have to rush as it is.*

Although this small group of survey participants does not represent all ISI teachers, their concerns do suggest other barriers to implementation of formative assessment. Nearly half of these teachers did not think formative assessment would enhance their students' science learning, and nearly half of these teachers also thought that their students lacked the ability to participate in these strategies. They felt it would be too time consuming to use them, given the wide range of students' learning abilities. A list of challenges is provided below.

Table 12: Challenges for using formative assessment strategies. (check all that apply)

Logistical challenges	
I did not have enough time because of too many other curriculum or other school related demands.	9 (82%)

I did not have enough time because of too many students.	7 (64%)
The formative assessment/ Next Step strategies did not fit with the science unit I was teaching at the time.	0 (0%)
The formative assessment/ Next Step strategies were not practical.	1 (9%)
Challenges related to the professional development or subject matter (check all that apply)	
The Professional Development did not give me sufficient preparation to implement the strategies.	3 (27%)
I did not think that the formative assessment or Next Step strategies would enhance my students learning in science.	5 (45%)
The professional development was good and was not a barrier.	3 (27%)
Challenges related to the range of student learners	
My students lacked the ability to participate in the formative assessment or Next step strategies.	5 (45%)
I did not know how to adapt the formative assessment and Next Step strategies for the range of learners in my classroom.	2 (18%)
It would be too time consuming to use formative assessment and Next Step strategies for the range of learners in my class.	5 (45%)
Other student reasons:	2 (18%)

In spite of the above-mentioned findings it's important to keep in mind that the survey questions were limited to asking about specific ISI formative assessment strategies and not other formative assessment strategies that teachers may have been using. The feedback from focus groups and interviews has also shown that many teachers were already using other formative assessment strategies or that they modified what they were doing as a result of the ISI training. As one survey respondent explained: *"I didn't do anything formal like post-it notes. Most of the formative assessment was done through discussion and the making meaning conference."*

Additional Benefits of Formative Assessment

Teachers underscored ways in which formative assessment enhanced the use of the notebooks and Making Meaning discussions. In fact, students were likely to put more effort into notebook entries, in part because teachers were regularly reviewing them, and also because students would were more often required to use the notebooks to participate in the Making Meaning discussions. As a result students began to take the work they did with their notebooks more seriously. An interesting finding from the focus group discussions was that teachers were using both the Notebooks and the Making Meaning conferences to formatively assess student understanding and as a Next Step strategy.

> *Well the first year we did the notebook, it seemed as though it was more of a hindrance. It was just one more thing to do, and I saw it that way, the students saw it that way. But we*

did it. We pushed through it. But now in the second year, in implementing some of these new strategies, I feel that the notebook is a really valuable tool. I've got kids, when they come to class, who are upset because they don't have their notebook with them. And they're not upset because I'm upset. They're not upset because, they're not upset because they know I'm going to come down on them, but they're upset because they're not going to be able to keep up with the class. They're not going to be able to record all of their data. And they say, well, if I just write it down on a piece of paper, the piece of paper may get lost and then I'm going to have to— You know, so the notebooking has become a great tool and a great resource that I think teachers and students have really embraced, at least at my level.

I think what came out of it for me, the thing that came out between the two years is the need for the making meaning conferences. We have them at the end of every unit, I want to say, or each lesson, but now when we're doing a lesson that may take two or three days, we make sure that they're doing, that we're meeting together before we close shop, because their responses are much, much better. They're more complete. Their thoughts are well thought out, and more than that, they're also giving more and more supporting evidence.

I just would agree that [because of the] making meaning conference, my conclusions are so much better than last year. And the kids will, even still like this girl here (referring to the her notebook), she will go back. Like she will find out something and go and add it to a lesson

Several teachers also reported using some of these strategies in other subject areas such as Mathematics and English Language Arts. In some instances, teachers found it easier to apply these strategies to other subjects instead of Science. Therefore, although the PD was focused on enhancing science instruction, the benefits have spread to other curricular areas as well.

I do the, use a math journal that's pretty similar, same kind of thing, with tabs and dividers, and kids use it to keep data, and we use a lot of the foldables and things we put in there, and so there's a lot of that is carried over in our math class as well.

The math teacher in my building, when she saw the science notebooks, wanted me to show her how to do that, so she can start doing it in the math.

Some of them [students] extend some of the formatting into more correctly, from what I took from the science, and they extend it over to the social studies, into the math, into the language arts, into the center. This is, we have it for everything now. And it's whatever book, I kind of just look to see if they've gotten some sort of a structure of how to set up a notebook, and it went on, because in the beginning, they didn't always know clearly. They did not always know what to do. And, you know, so as we went on, okay, what can we do? We can add pages in. How can we add pages? You know, so overall, they've got it, and then they try to make it better as they got through. And that's what I mostly look for, the improvement. I just like the idea of writing everything in a notebook, and we've really made it big at our school as well. So it made it easy to extend it in our building.

Conclusions and Recommendations

As we've seen throughout the report, there was a good deal of variation in the formative assessment instructional approaches that teachers used. Some employed those learned during summer professional development, many used modified versions, while others used strategies they learned in the past. Each of these approaches, as well as a combination of approaches, appeared to be valuable to those teachers using them. The more important *overarching result*, however, was that teachers who actively embarked on using formative assessment in their classrooms became more tuned in to student thinking processes and reasoning challenges. As a result, many were able to respond in a more timely and efficient way, tailoring lessons to improve understanding well before their students were faced with summative assessments.

Moreover, integrating formative assessment strategies enhanced teacher use of key ISI instructional resources—notebooking and Making Meaning conferences—along with specific Next Step strategies that had been introduced in prior training. Together, the FA strategies and instructional resources created a more interactive science learning experience for students in many classrooms.

In contrast, not all ISI teachers who participated in formative assessment training integrated FA strategies fully. Time and workload constraints became formidable barriers. Some teachers felt that they didn't have time to review notebooks or to pay individual and careful attention with a large number of students in the classroom. Others indicated that with a limited number of class periods in which to teach science, they couldn't always circle back to clarify confusions if they hoped to complete the required investigations.

There were other barriers as well. Survey data suggest that some teachers were not convinced that these strategies would enhance science instruction. Other teachers did not know how to modify them for students who were younger or who had specific communication and learning challenges/needs. A few found it hard to remember and utilize strategies they'd learned many months earlier.

Overall, these results suggest that formative assessment professional development and the subsequent integration of strategies in the classroom was a worthwhile endeavor, but that barriers and challenges must be addressed for these instructional strategies to have broader use and impact. Below, we offer *recommendations* that emerge from the data that may strengthen this component of ISI.

1) Many teachers expressed a need for follow-up professional development sessions. Such sessions would "refresh" their learning and encourage them to test out new strategies. Shorter sessions that occur periodically throughout the school year would offer the greatest support, as teachers could practice in their classrooms and then return to PD to debrief and troubleshoot problems. We've received positive reports regarding a couple of districts where follow-up support has been offered.

2) Not all teachers have the experience or confidence to modify instructional approaches that are new to them. Therefore, summer and/or follow-up PD should provide examples

of and opportunities to modify formative assessment approaches. *Specific* suggestions for addressing typical barriers such as time limitations and class size at each step in the process (identification, feedback, and next steps) are needed.

3) Teachers appreciated seeing videos of real teachers modeling strategies with their own students during the summer PD. Thus, developing additional videos showing modified versions of strategies or approaches to address persistent formative assessment challenges would be welcome. In some schools, observing another teacher or coach may be a viable option as well.

4) The PD facilitators need to show teachers how to use these strategies with diverse learners, in particular, students who are English Language Learners or who have learning disabilities. Also, there were requests for strategies appropriate for kindergarten students.

5) While individuals identified PD components of lesser value to them, there was no consensus (even within small groups) that certain strategies or aspects of the FA process should be eliminated. Thus, from this data set, we would not suggest removing anything in particular from the PD.

6) We learned that opportunities to practice formative assessment strategies with students attending summer school were embedded into the Summer 2014 formative assessment PD, and that teachers responded positively. Since we did not conduct an evaluation of this work, we cannot speak specifically to its success. However, it might be valuable for those involved to gather data about whether the extent and quality of teacher implementation was improved during the school year, as a result.

Appendix A: Focus group protocol:

ISI Teacher Focus Group Protocol

Thank you for taking time to speak with me/us today.

At any point during our conversation, you are free to skip a question or to ask me to stop the audio recorder should you wish to make a comment "off the record."

I. INTRODUCTION

Although you may have learned many things during the Summer 2013 ISI training, *the purpose of this focus group* is to better understand the experiences that you and other teachers in your group had with implementing the **formative assessment strategies** that you were taught at the ISI training. Your feedback will help us improve future formative assessment trainings.

As you might recall, during the formative assessment training, teachers:
- coded student notebook samples using a three color protocol (red, yellow, green) to indicate student readiness to proceed to the next lesson;
- practiced providing feedback within student notebooks on post-it notes;
- identified Next Step Strategies/lesson extensions to re-engage students in learning concepts/information/skills if required based on notebook analysis.

If there were other beneficial practices that you learned at the Summer 2013 ISI training, we are interested in hearing you, but we kindly ask that you share this only after we have finished asking all of the questions related to the formative assessment strategies, since we are short on time.

II. QUESTIONS:
The following questions can be asked with all teachers regardless of how many years of experience they have working with ISI.

Before we begin to ask you any questions we need to ask if you can **please make sure to identify yourself by your first name before giving any response**. In this way it will make it easier for us to review the recording.

1. Out of all the formative assessment (FA) strategies that you learned at the ISI summer training, which ones have you been able to use during this school year? *(Please ask them to raise their hands for each of the following strategies so that you can make note of which teacher used which strategies).*
    a. Coding student notebook samples using a three color protocol (red, yellow, green) to indicate student readiness to proceed to the next lesson;
    b. Providing feedback within student notebooks on post-it notes;

     c.   Identifying and using Next Step Strategies/lesson extension (mini lessons, line of learning, writing key points, etc.) to re-engage students in learning concepts/information/skills if required based on notebook analysis.

     d.   Are you using any other formative assessment strategies that were not taught at the ISI summer training? (*Only have them list these. At the end we will ask them to explain more.*)

(Directions to read aloud prior to questions 2-4) Thinking about the above-mentioned formative assessment strategies that you have used during this school year, can you recall a recent lesson and give us a concrete example to answer the following questions. If it is helpful, please refer to the sample notebooks you brought to answer the following questions:

2. Which of the formative assessment strategies that you used have helped provide you with evidence about your students learning?

3. If you recently extended instruction with your students, can you give an example of some Next Step or lesson extension strategies that you used with your students?

4. During this past school year, how often have you been able to do a Making Meaning conference with your students?

5. If you did have the opportunity to do any Making Meaning conferences, did any of the formative assessment strategies assist you in this process? If so can you give an example?

The following questions can be directed towards only teachers with at least two years of experience working with ISI.

1. How if at all did the FA strategies help you enhance the notebooking process compared to previous years? *If needed, use the following probes:*
     a. *Did it change or improve the way that you give feedback to students?*
     b. *Did you start to use the notebooks more and in different ways then before?*
     c. *Did it help inform you better as to how to modify your teaching?*

Final Wrap-up questions.
I'm going to ask a few final questions. It is likely that your responses may vary from each other. This is fine and expected, since your teaching situations are varied. What is more important to us is that you be as honest as possible.

1. Have any of these FA strategies been helpful with any other subjects that you are teaching? If so then which ones? Please provide an example of how you have used them.
2. On a scale of 1-10 how useful was the training on formative assessment? Please explain briefly why or why not. *(Please take note of the score each teacher gave)*
3. (Only ask this question if they mentioned it when responding to question 1.d.) Are you currently using any other formative assessment strategies in your science classes that were not taught at the ISI summer training? If so, can you explain why you prefer to use those strategies instead?

Appendix B: Logic model
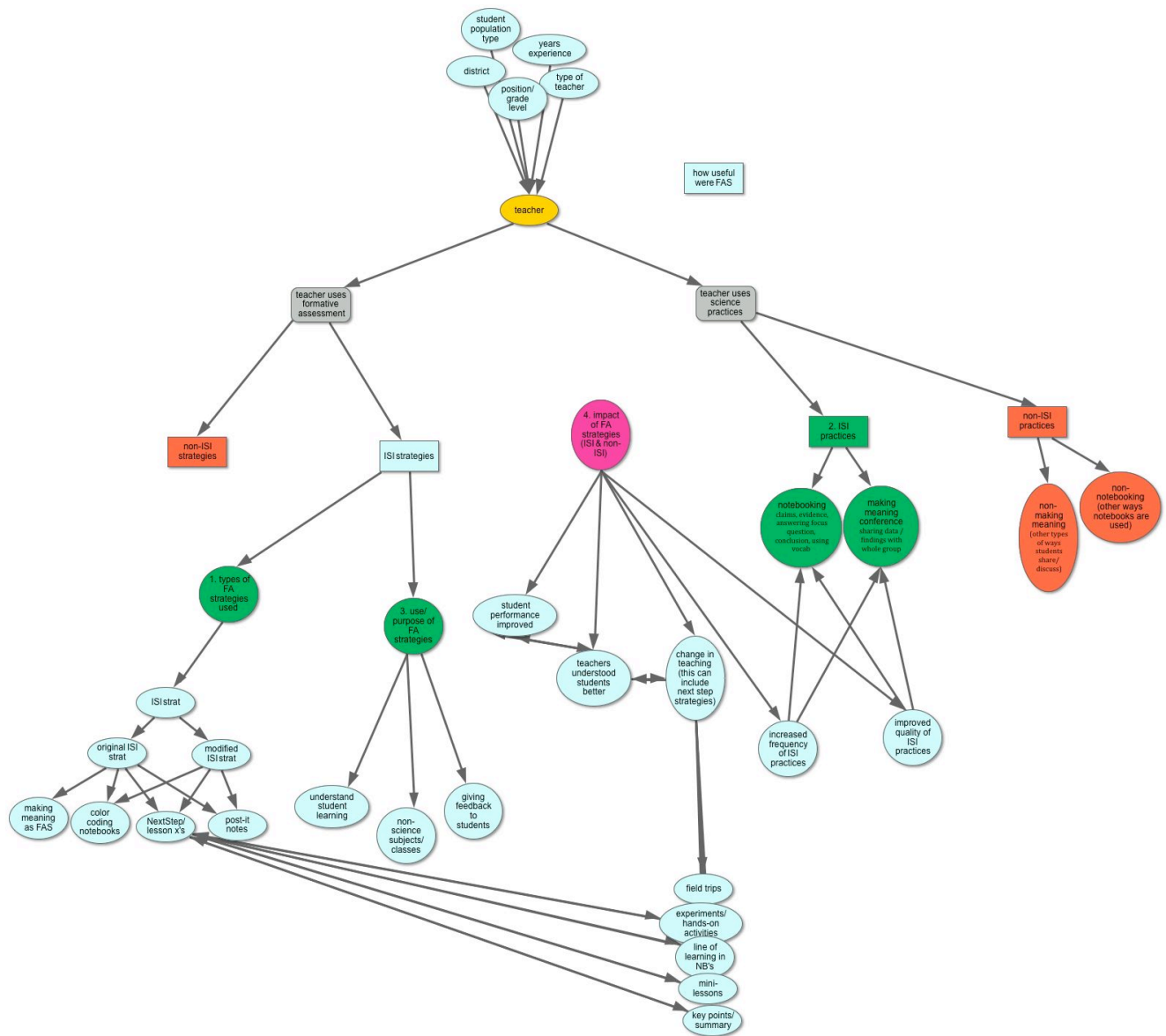
Appendix C: Code book

CODES FOR ANALYZING ISI FOCUS GROUP TRANSCRIPTS

Name	Definition
ISI strat	formative assessment strategy not taught at ISI training
Non-ISI strat	formative assessment strategy taught at ISI training
post-it	post-it notes
feedbck	post-it notes used to give feedback
exit slip	post-it notes used as an exit slip
other	post-it notes used for other purpose
color coding	color coding strategy
purpose	when a teacher uses a formative assessment strategy for a purpose
assess Std understanding	when teachers use a strategy for assessing students
help tchrs decide next step	when teachers use a strategy to decide which next step strategy to use.
help Std understanding	when teachers use a strategy to help improve student understanding
help Std communication	when teachers use a strategy to help students improve communication skills
reading skills	when teachers use a strategy to help students improve reading skills
vocabulary	when teachers use a strategy to help students improve vocabulary skills
clarify Std misconceptions	when teachers use a strategy to clarify student misconceptions
help Std make connections	when teachers use a strategy to help students make connections to other content or concepts they are learning
Other	when teachers use a strategy for other purposes
grading	when teachers use a strategy for grading students
motivate Std	when teachers use a strategy to motivate students
other purpose	when teachers use a strategy for other reasons
Impact	impact that the formative strategies have had on teachers, students, pratice, etc.
MM	Making Meaning conference
MM challenge	challenges for Making Meaning conference
notebooking	notebooking
QUESTION	any questions that come up while coding
ISI modified	ISI strategies modified by teachers
Next Step	next step strategy
ISI NS	ISI next step strategy
NS key Pts Summ	next step strategy: key points summarized
NS LoL	next step strategy: line of learning

NS mini-Lesson	next step strategy: mini-lesson
NS OTHER	next step strategy: other
NS sample stds work	next step strategy: review sample student work
Math Extension	Math extension
NS hands on	next step strategy: hands on
HO-PerformanceAsssmnt	next step strategy: hands on performance assessment
NS field trip	next step strategy: field trip

Appendix D: Follow-up Interview Protocol:

ISI Teacher Interview Protocol
Formative Assessment and Next Step Strategies w/ Student Examples

Introduction:
Thank you for taking part in this interview. During this call we will ask you to describe how you taught **one topic/idea** and the formative assessment process that accompanied the lessons.

I want to remind you that we will be recording the interview. Your responses will be confidential. However, if you would like me to stop recording at any point, please let me know and I'll turn off the recorder. May I record this interview?

This interview should take about 30-45 minutes and in order to ensure we finish on time we may need to interrupt you at certain points since our main focus it to understand how you use formative assessment strategies in the context of the lesson you will be describing to us.

Can you give me some background information about your students:
•What grade are your students in?

•Do you have three student notebooks that you can refer to during this interview?

•How would you describe each of these three students?: [*teachers should select a label for each of the three students*].

> A. *excelling while engaging in science work.*
> B. *does moderately well while engaging in science work*
> C. *struggles while engaging in science work*

Let's talk about the early stages of the investigation/lesson:
•What was the science topic/concept that your students were learning? [Focus Question]
> Probe: what were the key things you hoped your students would understand about this topic by the end of the science investigation?

•How did you get students to initially engage with this topic/idea?

•Did you ask them to make predictions…if so, what was the process for coming up with them? *[probe: did they write their predictions or any prior knowledge in notebooks?]*

•**For the three students:** Did you notice anything about their prior knowledge and/or ability to engage in this investigation? *[encourage teachers to consult notebooks]*
> *A.*
> *B.*
> *C.*

If yes:
> o What helped you realize that these students were at different levels of understanding or starting knowledge?

- o Did you need to do anything in response to what you noticed about each of student?
[notice if they mention using exit slips]

Let's move to the next stage of the investigation/lesson:
•How did the students go about investigating the topic/ideas and collecting data *(if applicable)?*

•What did they do immediately after they collected information or data?

•**For the three students:** What did you notice about how they collected data/information or the accuracy/completeness of the data/information that they collected? [encourage teachers to consult notebooks]
- *A.*
- *B.*
- *C.*

If yes:
- o Did you have concerns about these three students based on what you saw/heard?
- o Did you need to do anything in response?
[notice if they mention using post-its for feedback, color coding, exit slips]

Now let's talk about how students made sense of the what they had done during the investigation/lesson activities:
•After students had completed the activities/data collection, what did they do next?

•How did the activities you just described help students to "make meaning" of what they had been working on up to this point?

•**For the three students:** Did these activities enable you to assess their understanding?
  If not, did you use other formative assessment strategies to determine what they were
  understanding?
- *A.*
- *B.*
- *C.*

If yes, what strategies?
[notice if they mention using post-its for feedback, color coding, exit slips]

• what did he/she understand, were confusions or lack of understanding evident, did you see places where he/she might develop a fuller understanding? *[encourage teachers to consult notebooks]*
- *A.*
- *B.*
- *C.*
[notice if they mention using post-its for feedback, color coding, exit slips]

•What did you do next for each of these three students based on your assessment of what each had/had not learned?
- *A.*

B.

C.

Wrap-up
•Do you have any final thoughts about the value of formative assessment strategies, next step strategies/lesson extensions, and/or the notebooking process related to this lesson and/or these students? in general?

[if at the end they haven't mentioned using FAS or NS with students that were doing really well then probe:]
•Besides the lesson we just discussed were there other lessons you did with students where you used FAS or NS's for students that were doing very well?

Feedback on the Formative Assessment PD
During the summer of 2013 you participated in the ISI Professional Development where you learned about different Formative Assessment and Next Step strategies. Some of these strategies included:
    a. Coding student notebook samples using a three color protocol (red, yellow, green) to indicate student readiness to proceed to the next lesson;
    b. Providing feedback within student notebooks on post-it notes;
    c. Identifying and using Next Step Strategies/lesson extension (mini lessons, line of learning, writing key points, etc.) to re-engage students in learning concepts/information/skills if required based on notebook analysis.

•On a scale of 1-10 how would you rate your experience of the Formative Assessment PD you received last year?

•Please explain what would have made you rate it as a 10?

•If you were to redesign the PD for the formative assessment or Next Step strategies…
    • What else would you include? _____
    • What would you eliminate? _____

Next steps:

    • *[If they provided meaningful feedback during the interview]:* Would you be interested in participating in Part 2 of this research project and if so would you be able to make copies of the notebooks we were discussing during this interview?

Appendix E: Challenges Survey

ISI Survey: Math Extensions & Formative Assessment

INFORMED CONSENT INFORMATION

The evaluation of the Indiana Science Initiative (ISI) is being conducted by TERC, a nonprofit educational research and development organization located in Cambridge, MA. Your participation will help us to evaluate the effectiveness of the ISI professional development that focuses on formative assessment and math integration in your science classroom. After completing this survey we will send you a $15 gift card.

The information you provide in this survey will be confidential – only TERC evaluators will have direct access to your responses. Although we gather identifying information such as your name and email address, we will remove this information before analyzing the data and we will not identify individual teachers in any of our data summaries.

Your participation in this survey is entirely voluntary and has no impact on your participation in the Indiana Science Initiative.

Thank you for sharing your insights. If you have any questions about this study or your participation in it, please call Audrey Martinez-Gudapakkam at TERC, 617-873-9775 or email her at audrey_martinez-gudapakkam@terc.edu. If you would like to speak to someone outside of the project, you may contact Rena Stroud of TERC's IRB. She can be reached at (617) 873-9868 or at rena_stroud@terc.edu.

 By selecting "YES" below, you indicate that:

I understand that my participation is entirely voluntary and confidential; and
I agree to contribute my insights about ISI formative assessment and math integration work through a survey.

1.   Are you willing to participate in Indiana Science Initiative (ISI) survey described above?
   • Yes
   • No

BACKGROUND INFORMATION
2.   School district:

3.   Grade level:
   • Kindergarten
   • Grade 1
   • Grade 2
   • Grade 3
   • Grade 4
   • Grade 5
   • Other:

4.   Number of years teaching at current grade level

5.   Background in mathematics and or math education (either pre-service or while teaching):
   - None
   - 1-2 undergraduate courses or the equivalent
   - 3-5 undergraduate courses or the equivalent
   - 6-10 undergraduate courses or the equivalent
   - Undergraduate degree in math or math education
   - Graduate degree in math or math education

PARTICIPATION IN MATH EXTENSION PD

6.   During the 2013 ISI Summer Professional Development did you participate in the Math Integration workshop led by Signe Kastberg, Laura Bofferding, Susan Gran, and/or Sam Thomas?
   - YES
   - NO

CHALLENGES FOR INTEGRATING MATH AND SCIENCE

We understand that there were several factors for why many teachers couldn't use the math extensions. This is why your feedback is important to help us make improvements to the professional development.

Below is a list of the math extensions by grade level for your reference:

	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
1	Fabrics Unit: Sort & graph	Measure towers	Cost of top combinations	Strides & Wheels - linear	Graphing investigations	Finding quantities & volume
2	Fabrics Unit: Comparing threads	Finding and sorting solids/ Venn diagrams	Which Runway is longer/ combine tracks	Balance Mass/ Weight	Pick the best charger	Ten percent evaporation
3	Fabrics Unit: Colorful caps/ count and combinations	Adjusting portions of a drink	Sliders and Stackers Using solids	Crayfish - Liquid volume	Patterns in circuits	Partitioning whole

7.   Logistics: If you were unable to use some/all of the mathematics extensions due to logistics, please check all that apply.
   - I did not have enough time, because of too many school closings or delays due to weather
   - I did not have enough time because of too many other curriculum demands.

- The math in the extensions did not fit with the math unit I was teaching at the time.
- Other logistical reasons:

8. Math Integration Professional Development: If you were unable to use some/all of the mathematics extensions, please check all that apply
- The professional development did not give me sufficient preparation to implement the extensions.
- I did not think that the math extensions would have enhanced my students learning in mathematics.
- I did not think that the math extensions would have enhanced my students learning in science.
- Other professional development reasons:

9. Range of student learners: If you were unable to use some/all of the mathematics extensions, please check all that apply.
- My students lacked the basic math skills they would have needed to access the math extensions.
- I did not know how to adapt the extensions for the range of learners in my classroom.
- It would be too time consuming to adapt the extensions for the range of learners in my class.
- Other student reasons:

10. Please list any other reasons why you did not use the math extensions.

CHALLENGES FOR INTEGRATING MATH AND SCIENCE CONTINUED

11. What type of school support was available to you while implementing math extensions? (check all that apply)
- None
- Site coordinator
- Math or science coach/facilitator
- Grade level team meetings
- Other

12. If you were to redesign the PD for the math extensions…
- What else would you include?

- What would you eliminate?

13. Please provide additional comments about difficulties AND/OR suggestions you might have that would facilitate your use of the math extensions:

PARTICIPATION IN FORMATIVE ASSESSMENT PD
14. During the 2013 ISI Summer Professional Development did you learn about any Formative Assessment and Next Step strategies? (e.g., Color coding notebooks, using post-its for feedback to students, mini-lessons, line of learning, writing key points, etc.):
- YES

- NO

TYPES OF FORMATIVE ASSESSMENT STRATEGIES

15.   Please check off the types of formative assessment and Next Step strategies you recall using during the past school year with your students and indicate to what extent you used them.

	Never used	A little (1-2 times during school year)	Somewhat (3-4 times during school year)	Used extensively (more than 4 times during school year)
Color coding notebooks to indicate student readiness				
Providing feedback to students in with post-it notes				
Mini-lessons				
Line of learning (in notebook)				
Writing key points				

CHALLENGES WITH FORMATIVE ASSESSMENT
Please check off as many reasons that apply as to why you were not always able to use the Formative Assessment or Next Step strategies that were listed above. (select all that apply)

16.   Logistics:
- I did not have enough time because of too many other curriculum or other school related demands.
- I did not have enough time because of too many students.
- The formative assessment/ Next Step strategies did not fit with the science unit I was teaching at the time.
- The formative assessment/ Next Step strategies were not practical.
- Other logistical reasons:

17.   The Professional Development:
- The Professional Development did not give me sufficient preparation to implement the strategies.
- I did not think that the formative assessment or Next Step strategies would enhance my students learning in science.
- Other professional development reasons:

18.   Range of student learners:
- My students lacked the ability to participate in the formative assessment or Next step strategies.
- I did not know how to adapt the formative assessment and Next Step strategies for the range of learners in my classroom.

- It would be too time consuming to use formative assessment and Next Step strategies for the range of learners in my class.
- Other student reasons:

19.   Other reasons not in the categories listed above:

CHALLENGES WITH FORMATIVE ASSESSMENT CONTINUED:

20.   If you were to redesign the PD for the formative assessment/ Next Step strategies…
- What else would you include?

- What would you eliminate?

21.   Please comment on any other factors that contributed to your use or inability to use the formative assessment/ Next Step strategies:

22.   Please provide any additional comments about difficulties AND/OR suggestions you might have that would facilitate your use of the formative assessment / Next step strategies:

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