2008

DISCOURSE IN INQUIRY SCIENCE CLASSROOMS (DiISC): REFERENCE MANUAL

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Baker, Dale R.; Beard, Rachelle; Bueno-Watts, Nievita; Lewis, Elizabeth B.; Özdemir, Gokhan; Perkins, Giota; Wong, Sissy; and Yaşar-Purzer, Senay, "DISCOURSE IN INQUIRY SCIENCE CLASSROOMS (DiISC): REFERENCE MANUAL" (2008). *Faculty Publications: Department of Teaching, Learning and Teacher Education*. 121.
http://digitalcommons.unl.edu/teachlearnfacpub/121

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Technical Report No. 001
The Communication in Science Inquiry Project (CISIP)
Arizona State University

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This material is based upon work supported by the National Science Foundation
under Grant No. DRL-0353469

DISCOURSE IN INQUIRY SCIENCE CLASSROOMS (DiISC): REFERENCE MANUAL

Introduction

One of the greatest challenges facing scholars and funding agencies interested in reform is determining the impact of classroom practice on student achievement. The degree to which this effect can be determined is contingent upon instruments that measure teachers' ability to enact specific instructional strategies. Frequently, a general instrument will not do because it was not designed to measure the unique focus of a professional development program or a set of variables of interest to researchers.

Consequently, specific instruments should be developed to allow researchers to measure fidelity of classroom implementation. Fidelity of implementation is always the first step in determining effectiveness. For without fidelity of implementation, it is impossible to determine whether what the teacher does has an impact on student achievement. This manual reports on the development of just such an instrument, called the Discourse in Inquiry Science Classrooms (DiISC). The instrument was developed to measure teachers' use of strategies in their classrooms to foster a science classroom discourse community (SCDC) as a way of furthering achievement in science. The DiISC instructional strategies that support the creation of a SCDC address oral and written discourse, and academic language development embedded in inquiry and they also reflect learning principles. We believe that the creation of the DiISC is especially timely for two reasons. First, science educators are beginning to focus on communication in science as a learning tool to increase students' conceptual understanding and achievement in science. Second, we need an instrument to measure teachers' ability to support the academic language development in science of the increasing number of English Language Learners (ELLs) in our schools.

The (DiISC was created by the Arizona State University research team for the Communication in Science Inquiry Project (CISIP). CISIP was funded by the National Science Foundation (grant # 0353469) and a two Improving Teacher Quality (ITQ) grants (grant # ITQ07-05ASU, ITQ08-02ASU) from the Arizona Board of Regents. A copy of the DiISC can be found in Appendix A.

The Arizona State University research team consisted of Dale Baker (CoPI of the NSF grant and PI of the ITQ grants), Rachelle Beard, Nievita Bueno-Watts, Elizabeth Lewis , Gohkan Özdemir, Gita Perkins, Sibel Uysal, Sissy Wong, and Şenay Yasar-Purzer. This team had a strong background in psychology, geology, biology, chemistry, physics and engineering as well as science education and teacher education. This work could not have been conducted without their insights, knowledge, and hard work. The research team was especially helpful in the creation, modification, and testing of the DiISC and the countless hours of classroom observations made by each member of the team.

The DiISC is an instrument for observing teachers, not students. It describes what teachers do and focuses on five sets of instructional strategies that form the scales of the DiISC. These scales are *Inquiry, Oral Discourse, Writing, Academic Language Development* and *Learning Principles.* Consequently, the stems of many of the items start with the phrase, "The teacher…", as in “The teacher creates an environment that supports inquiry”.

The DiISC is a research instrument and should not be used by untrained observers. Observer should have a good understanding of the meaning of the items on each of the scales and inter observer reliability should be established before going into classrooms. We encourage others interested in the role of communication in learning science to use the DiISC in their own research. Inquiries and requests for additional information can be obtained by emailing Dale Baker (dale.baker@asu.edu).

Background

The Communication in Science Inquiry Project (CISIP)

CISIP is a science teacher professional development program supported by the collaborative efforts of Arizona State University and the National Center for Teacher Education (NCTE) located at the Maricopa Community College District. Michael Lang of the NCTE, faculty from Maricopa Community Colleges, and teacher leaders have had primary responsibility for the delivery of the professional development. The Arizona State University team has had primary responsibility for the research component of the project. This includes the development of the DiISC, classroom observations, and measures of student achievement.

The CISIP model considers scientific talking and writing as central pieces of science lessons. CISIP also emphasizes academic language development and learning principles in a student-centered curriculum. In the CISIP model, inquiry is a vehicle for including written and oral scientific discourse, academic learning strategies, and learning principles in science instruction. CISIP offers an integrated approach, combining these components to create science classroom discourse communities to increase students’ science achievement.

The CISIP model does not separate the learning of content from learning about pedagogy or students and presents content within the context of inquiry. This decision is supported by the research that finds that knowledge of content alone is not enough preparation for teaching (Feiman-Nemser & Parker, 1990). However, we do acknowledge that content knowledge is a critical component in the development of pedagogical content knowledge (Abell, 2007) and that there are strong correlations between background in science (content knowledge) and the use of a variety of preferred instructional strategies (Abell, 2007) and teaching effectiveness (Druva & Anderson, 1983). The research indicates that to be an effective teacher content knowledge must be well organized and well integrated. Teachers whose knowledge of content lacks organization and integration cannot help student's link factual knowledge to larger conceptual frameworks and are unable to help students make connections to the natural world (Fisher & Moody, 2000; Wandersee & Fisher, 2000).

Fidelity of Implementation

Fidelity of implementation for K-12 curricular interventions has been defined in various ways (Fullan, 2001; Louks, 1983; National Research Council, 2004), but all definitions have as their central premise that professional development programs were delivered as planned and that teachers' classroom practices were faithful to the professional development. Even though much has been written about fidelity of implementation from a conceptual perspective, the educational research literature lacks a sufficient body of research to provide guidance as to how fidelity of implementation of curricular interventions can be measured (O'Donnell, 2008). This is especially the case for CISIP because, until recently, learning science through talking and writing has been largely ignored (Hand, Alvermann, Gee, Guzzetti, Norris, Phillips Prain, &Yore, 2003).

Measuring fidelity of implementation is important because fidelity is linked to the effectiveness of an intervention. For example, Blakely, Mayer, Gottschalk, Schmitt, Davidson, Roitman, and Emshoff (1987) found that effective implementation was associated with high fidelity and ineffective implementation with low fidelity. Classroom studies also find that statistically higher student outcomes are associated with greater fidelity of implementation (O'Donnell, 2008). On the other hand, interventions that require less fidelity are more likely to be adopted by teachers quickly and to be sustained over time (Rogers, 2003). Determining how much fidelity is needed for classroom impact is important when evaluating programs and designing research studies.

Theoretical Overview of the DiISC

The DiISC measures deep processing of scientific concepts (Chin & Brown, 2000) through the creation of science classroom discourse communities (SCDCs). These communities address communication in science and the science language acquisition needs of all students, but especially second language learners. Thus, our model is one of situated learning where learning is a social activity (Lave & Wegner, 1992; Wegner, 1998) and learning how to talk and write in the genres of science contributes to meaning making and the development of structured and coherent ideas (Kelly, 2007; Rivard & Straw, 2000).

The DiISC also measures the implementation of the language principles and theories described in Carrasquillo and Rodriquez (1996) and the *Cognitive Academic Language Approach* (Chamot & O'Malley, 1987) for academic language development. The DiISC relies heavily on the research in writing to learn, especially in science (Klein, 1999; Yore, Hand & Prain, 1999), with an emphasis on the knowledge transformation model of Bereiter and Scardamalia (1987).

We focus on learning for understanding and measure the implementation of learning principles (assessing prior understandings, linking fact to conceptual frameworks, metacognitive monitoring, setting performance expectations, and providing formative and summative feedback) derived from the research in the science of learning described in *How People Learn* and *How Students Learn* (Bransford, Brown, & Cocking, 2000; National Research Council, 2005) to help teachers create environments that support learning.

Our model is also based in social constructivism and as such emphasizes science as inquiry as a way to build knowledge (National Research Council, 1996). Within inquiry, there is a focus on the nature of scientific communication emphasizing rhetorical stances, text structures, and genres and patterns of argumentation as reflected in the modernist views of Halliday and Martin (1993).

Appendix B contains a list of articles for those who wish to read more about the research related to inquiry, written and oral discourse, academic language development in science, and learning principles.

The Scales

Inquiry Scale

The inquiry scale measures the degree to which teaching takes place in a student-centered classroom where students are engaged in hands-on activities to explore the natural world with varying degrees of investigative independence. This scale was designed to reflect the essential features of scientific inquiry. The major consideration in developing items for this scale was to identify observable behaviors realistically found in inquiry-oriented classrooms.

The recent reform movements and the *National Science Education Standards* identify inquiry in classrooms as essential to effective science teaching and student learning (National Research Council, 1996). The current science education community has also agreed on the important role of inquiry-based instruction in science classrooms. Doing inquiry in classrooms requires teachers to create an environment where students engage in a set of complex cognitive processes (Windschitl, 2004). These processes are found on the *Inquiry* scale. They are:

- Engaging with scientifically oriented questions.
- Giving priority to evidence, which allows students to develop and evaluate explanations that address scientifically oriented questions.
- Formulating explanations from evidence to address scientifically oriented questions.
- Evaluating explanations in light of alternative explanations, particularly those reflecting scientific understanding.
- Communicating and justifying proposed explanations.

Oral Discourse Scale

The *Oral Discourse* scale measures the degree to which teaching bridges everyday experiences and scientific discourse to create a SCDC. Scientific discourse in a classroom setting has been defined as knowing, doing, talking, reading, and writing (Moje, Collazo, Carillo, & Marx, 2001) or as the combination of scientific ways of talking, knowing, doing and using appropriate form of evidences (Lemke, 1990).

The scale focuses on whether the teacher is providing students with opportunities to build scientific vocabulary and engage in peer-to-peer discussions that support the building of scientific explanations. It also focuses on whether the teacher is providing opportunities for students to explore the nature of scientific communication (i.e., a scientific classroom discourse community).

Although science is defined as making sense of the natural world, the investigation of nature is only part of the knowledge generation process (Kittleson & Southerland, 2004). Scientific knowledge is also socially and culturally constructed (Alexopoulou & Driver, 1996; Kelly & Crawford, 1997; Kelly & Green, 1998) through the negotiation of meanings. The key element of this negotiation is oral discourse. From this perspective, group processes and dynamics are central to understanding how knowledge is created and negotiated in a science classroom (Kelly & Green, 1998).

Newton, Driver, and Osborne (1999) argue that scientific discourse develops conceptual understanding, brings a scientific community atmosphere into classroom, and contributes to the general education of the student. Since scientific discourse is socially mediated and constructed, students need to learn discourse norms through both participation in the discourse and explicit instruction from teachers (Kelly & Chen, 1999).

Consequently, the following processes are found on the *Oral Discourse* scale:

- Promoting discourse through questioning.
- Engaging in peer to peer discussion.
- Modeling scientific discourse and vocabulary.
- Bridging everyday experience and the language of science.
- Emphasizing the nature of science.

Writing Scale

The *Writing* scale measures the degree to which teaching provides students with opportunities to pre-write, write, and share their writing. These activities support acquiring the language patterns and vocabulary to communicate scientific ideas, use science notebooks, and write in a variety of genres. Writing also supports the development of a scientific classroom discourse community.

Traditionally, writing has been used for evaluation purposes in science classrooms but it is receiving more attention in the science education community with writing-to-learn strategies (Keys, 1999). Several researchers assert that writing is not only a reflection of conceptual understanding but that it is also a tool to generate understanding (Halliday & Martin, 1993; Lemke, 1990).

In his review, Rivard (1994) summarized what the research of writing-to-learn strategies tells us. He wrote that "Students using appropriate writing-to-learn strategies are more aware of language usage, demonstrate better understanding and better recall, and show more complex thinking content (p.975)." His review indicated that expository writing such as explaining, and summarizing effectively promoted learning experiences in science. Furthermore, explicit teaching of genres of scientific writing with clear descriptions, purpose, and audience in mind enabled students to organize relationships among elements of text and knowledge (Callaghan, Knapp, & Noble, 1999; Keys, 1999).

The following processes are found on the *Writing* scale:

- Engaging in prewriting.
- Using rubrics to rewrite and revise.
- Writing to acquire the language patterns and vocabulary to communicate scientific ideas.
- Writing to learn content.
- Using notebooks as a learning tool.

Academic Language Development Scale

The *Academic Language Development* scale measures the degree to which teaching supports academic language development in science through the use of visual aids, supplemental resource materials, and clear instruction throughout the lesson. It also measures the degree to which lessons build on students' language and culture and provide opportunities for students to acquire scientific vocabulary.

The specific items on the *Academic Language Development* scale reflect strategies adapted from Herell and Jorden (2003) as well as the research in science education that addressed linguistically diverse Students (Fradd & Lee, 1999; Lee & Fradd, 1996). The essential *Academic Language* strategies are:

- Creating a framework that builds upon students' language and promotes peer-to-peer interaction.
- Supporting use of language and building vocabulary by modeling and contextualizing academic language; and using visuals, gestures, demonstrations, and supplemental materials.
- Adapting the level of questions so that students can respond according to their stage of language acquisition.
- Providing instruction in learning strategies and establishing clear expectations.

Learning Principles Scale

The *Learning Principles* scale measures the degree to which teaching provides opportunities for students to assess prior knowledge, make conceptual connections, and engage in metacognition. The scale also measures whether the teacher models scientific thinking, establishes community norms, and promotes an academic focus that supports learning science. The *Learning Principles* scale is the largest scale of DiISC and is based on the principles addressed in *How People Learn* and *How Students Learn* (Bransford, Brown, & Cocking, 2000; National Research Council, 2005).

The scale measures whether the teacher is identifying students' prior knowledge because learning can not be isolated from what students already know. Students' conceptual knowledge is heavily influenced by everyday experiences with natural phenomena and events. Consequently, the explanations of novices' often include non-scientific explanations based on their daily experiences. In order to teach normative scientific theories and concepts, teachers have to know what students think and then adjust instruction accordingly.

Activating prior knowledge also starts the metacognitive processes that are central to self monitoring. Students should be aware of what they know, what they do not know, what they need to know, and how to find missing or necessary information. If students are to become effective learners they must "develop the ability to take control of their own learning, consciously define learning goals, and monitor their progress in achieving them." (National Research Council, 2005, p.4-10).

The National Research Council (2005) also draws attention to the essential role of factual knowledge and conceptual frameworks in developing an understanding of science. To develop students' conceptual understanding the teacher must not teach facts in isolation but place factual knowledge in a conceptual framework. The teacher must also present concepts using multiple detailed representations in order for concepts to become meaningful.

In addition, the reserch tells us that students' academic performance relies on the amount of feedback they receive (Black & Williams, 1998). Feedback must be timely and specific in order to be useful. It should identify errors in thinking and guide students to develop understanding. The following processes are found on the *Learning Principles* scale:

- Assessing prior knowledge and modifying instruction based on students' prior knowledge.

- Linking facts to conceptual frameworks.
- Developing students' ability to engage in metacognition.
- Providing academic feedback.

Test Development

An initial form of the DiISC was developed by the research team to measure fidelity to the CISIP model by evaluating lessons and teachers' instructional behaviors in the classroom. Observable teaching behaviors for the DiISC were generated in light of the research literature and the National Science Education Standards (1996). A list of instructional strategies were generated for each scale and discussed by the team. Instructional strategies were either eliminated or combined based on the discussions that included continual reference to the research literature and standards. The items on the scales were then discussed with the CISIP leadership team. In addition to Dale Baker and Michael Lang, The leadership team consisted of science and English language faculty from the Maricopa Community College system; and teachers with expertise in teaching science, the use of science notebooks, and teaching English Language Learners.

Feedback from the leadership team, as well as CISIP's evolving vision, and the professional development activities provided to teachers were used to revise items. The first draft of the DiISC consisted of five scales: Inquiry, Writing, Oral discourse, English Language Learners, and Metacognition. Each scale consisted of 5-7 items with sub-items describing instructional strategies.

The DiISC was field tested in the second phase of development. A series of classroom observations and interviews were conducted to the determine ease of use, and inter rater reliability. After each classroom observation, the research team discussed their observations and how they rated instructional strategies (and implicitly the lessons) item by item. This process helped to establish the alignment of the instrument, the degree of inter rater reliability, and a common understanding for each item. We also refined the wording of the items, and added or eliminated items based on shared judgment.

The DiISC was then reframed using the scale scores and the experience of field observations. First, we re-conceptualized the English Language Learner scale to be more inclusive. We agreed that some English Language Learner instructional strategies were good for all students because all students are acquiring the language forms used in science. However, because of the evolving professional development we felt that our focus should be the development of academic language in science within an SCDC. Therefore, the English Language Learner scale was renamed the *Academic Language Development* scale. Explicit items regarding the nature of science communication were added to the *Academic Language Development* scale to measure the goal of creating a scientific discourse community in the classroom. Second, we asked for more global feedback from district administrators responsible for curriculum and from our outside evaluator. Finally, the Likert scale that was used to rate observation items was reduced from six-points to a four points to improve observer agreement. This constituted the second draft.

The third draft was made after a 2006 professional development summer institute. The focus of the institute was on essential components of the model and teachers were expected to create "signature lesson" plans by integrating selected CISIP instructional strategies into their curriculum. The research team met with the teachers and professional development providers to determine whether we had a shared understanding of the model and what CISIP instructional strategies looked like in the classroom. As a consequence of these discussions, some items on the DiISC were rephrased, eliminated, or moved to a different scale. New items were also added.

The third draft included two important modifications. First, a new scale called *Learning Principles* was created replacing the metacognition scale and the metacognition items were placed on the *Learning Principles* scale with slight changes in wording. The *Learning Principles* scale included additional items that operationalized the learning principles for assessing prior knowledge, setting performance expectations, connecting factual knowledge to conceptual frameworks and providing academic feedback. Second, we limited the components that described each item to three in order to increase inter-rater reliability. In other words, each item on the scale now included three different observable teacher behaviors. This draft of the DiISC was then shared with all of the participants and feedback was used for additional revisions.

The fourth draft was based on telephone interviews with experts in academic language development and teachers resulting in modifications of the *Academic Language Development* scale. The fifth and final draft included a rubric to aid observers in making decisions about the Likert scale (0-4) ratings of the items and to further improve the inter rater reliability. Table 1 summarizes the development process and also indicates how the development process addressed validity.

Table 1: DiISC Development Process

Stages	Action	Improvement/modification
Draft I - Content Validity	Literature review Development of the items	1st draft of DiISC
Draft II - Construct Validity and Face Validity	Field testing (pilot study) Testing inter rater reliability Conversations with teachers, district administrators, outside evaluator	Revisions of the items with expert judgment Transforming English Language Learner scale to *Academic Language Development* scale Adding Nature of Science Communication items Reducing the 6 point Likert scale to a 4 point scale
Draft III - Construct Validity and Face Validity	Conversations with professional development providers and teachers Revision of professional development Testing inter rater reliability	Revisions of the items based on expert judgment Creating *Learning Principles* scale Specifying 3 components for each major items to improve inter-rater reliability
Draft IV - Construct Validity	Feedback from experts on Academic Language Development Teacher Phone Interviews	*Academic Language Development* scale modified again
Draft IV	Testing inter rater reliability	Development of a rubric for scale values

Psychometric Properties

Validity

The development of the DiISC was a recursive process in which items were designed, evaluated, and modified several times to determine whether they were appropriate, meaningful, and useful. This process contributed to the content, face, construct, and concurrent validity of the instrument.

Content Validity

The content validity of the instrument was established using two methods. First, the items were written to reflect the theoretical model, standards, and the research literature. Second, we sought the input of experts who examined the items to determine whether the items did indeed reflect the theoretical model, standards, and the research literature.

Face Validity

Face validity was established using an iterative process in which drafts of the DiISC were examined by the professional development providers and project leadership team. We also called upon the expertise of school district administrators responsible for curriculum, and the project's outside evaluator. Feedback from teacher leaders and teachers who were participating in the professional development was also used to establish face validity.

Construct Validity

Construct validity was determined by field testing the instrument in schools to determine whether the items captured all of the aspects of classroom teaching that we were interested in observing. We also used inter rater reliability to determine whether users understood the underlying construct of the scales. Conversations with teachers and the professional development providers were also held to determine whether they understood the items to be measuring the underlying construct of the scales.

Concurrent Validity

Concurrent validity was established by computing the correlation between the DiISC scores from classroom observations with the *My Science Classroom Survey* given to students. The *My Science Classroom Survey* is a measure of students' perceptions of their teachers' use of the strategies found on the DiISC. The survey scores of 187 students and the classroom observation DiISC scores of their teachers were correlated. A statistically significant correlation ($r=.80$, $p<.00$) was found between the observations and student perceptions.

Reliability

Inter Rater Reliability

An intraclass correlation was used to calculate the inter rater reliability. This technique is used when there are more than two raters, raters do not always observe the same individual, and the data can be considered interval like. Our data meet these criteria. We had multiple observers who did not always work in the same pairs to observe the same teachers. When working alone, an individual observer did not always make multiple observations of the same teacher. Furthermore, the Likert scale of the DiISC met the criterion of interval like data. The intraclass correlation we obtained was $R=.90$ indicating a very high degree of agreement among raters and across teachers.

Exploratory Factor Analysis

Factor Analysis

Two-hundred-and-four classroom observations were used in the factor analysis. One-hundred-and-sixty of the observations were of teachers who had participated in the middle school and high school CISIP professional development or were part of a comparison group. Forty-four observations were baseline observations of 5th and 6th grade teachers just beginning professional development. The grade range of observed teachers was upper elementary/middle school to high school (5th through 12th grade).

Three criteria were used to determine the number of factors to rotate. These were the scree test, Eigen values, and the interpretability of the factor solution. Five factors were rotated using a Varimax rotation procedure based on these criteria, which also reflected the initial five scale structure of the instrument.

Analysis

The factor analysis is presented in 2. The first factor was labeled *Teaching Inquiry Skills* and accounted for 12.04% of the total variance. The second factor, *Teaching Discourse Strategies to Learn Content,* accounted for 10.23% of the variance. The third factor, *Teaching Discourse Strategies to Support Nature of Science (NOS) and Metacognition,* accounted for 9.74% of the variance. The fourth factor, *Teaching Formal Writing in the Context of Student Abilities,* and accounted for 8.4 of the variance. The fifth factor, *Assessing Students and Modifying Instruction*, accounted for 5.7 of the variance. Total variance accounted for by these five factors was 46.1%.

The factor structure of the analysis differs from the original organization of the DiISC, which was designed to reflect the major components of the instructional strategies presented to teachers (i.e., inquiry, oral and written discourse, academic language and learning principles). However, the factor structure accurately reflects how teachers implement strategies in their classrooms. That is, teachers did not use strategies in isolation but used them in various combinations to reach specific student learning outcomes. These outcomes are reflected in the factor labels of *Inquiry Skills, Content*, *NOS and Metacognition*, and *Writing*. *Assessing and Modifying Instruction* loads on a separate factor and based on our observations rarely occurs.

This factor analysis suggests that some items are not uniquely identified with a single factor. For example, “Promotes peer to peer discussion,” “Engages students in NOS discussions,” and “Engages students in writing for claims and evidence” load on both factor 1 (*Inquiry Skills)* and factor 3 (*NOS and Metacognition)* and from an instructional perspective are both needed to promote inquiry and understanding the nature of science.

Table 2: Factor Structure and Item Loadings

Item	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
Teaching Inquiry Skills					
Creates an inquiry environment	**0.803**	0.093	0.221	-0.038	0.013
Engages students in asking questions	**0.773**	0.014	0.008	0.048	0.054
Provides opportunities to design/plan exploration	**0.713**	-0.023	-0.008	0.199	-0.104
Provides opportunities to explain phenomena	**0.581**	0.312	0.207	0.123	0.094
Provides opportunities to construct scientific arguments	**0.49**	0.212	0.188	0.127	0.142
Teaching Discourse Strategies to Learn Content					
Promotes Discourse through Questioning	0.378	**0.433**	0	0.137	0.288
Bridges everyday experiences and scientific discourse	0.227	**0.71**	-0.021	-0.096	0.211
Models scientific discourse and Vocabulary	0.177	**0.774**	0.158	-0.1	-0.048
Instruction in writing content, forms and processes	-0.075	**0.397**	0.204	0.335	-0.256
Provides opportunities for students to acquire vocabulary	-0.251	**0.522**	0.263	0.254	0.003
Uses visual aids to communicate	0.207	**0.55**	0.142	0.068	-0.019
Builds lessons on students' language and culture	-0.062	**0.567**	-0.127	0.194	0.112
Situates factual knowledge in conceptual frameworks	0.04	**0.426**	0.334	-0.147	0.349
Opportunities for students to review concepts	-0.041	**0.542**	0.319	0.098	0.273
Teaching Discourse Strategies to Support NOS and Metacognition					
Promotes peer to peer discussion	**0.441**	0.104	**0.457**	0.111	0.306
Engages students in NOS discussions	**0.358**	0.183	**0.361**	0.043	0.265
Engages students in writing for claims and evidence	**0.314**	0.339	**0.384**	0.07	**-0.425**

Table 2: *Continued*

Item	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
Engages students in prewriting about science concepts	0.332	-0.019	**0.499**	0.035	-0.3
Provides instruction for using notebooks as a learning tool	0.171	0.337	**0.519**	-0.019	-0.043
Uses clear instructions of expectations	0.253	0.144	**0.626**	-0.004	0.099
Provides instructs for student interactions	0.335	0.039	**0.512**	0.192	0.295
Teaches with and models embedded metacognition	0.086	0.14	**0.579**	0.35	0.335
Communicates norms for discourse	0.144	0.176	**0.55**	0.181	0.071
Communicates expectations with rubrics and exemplars	-0.122	-0.07	**0.645**	0.053	-0.1
Teaching Formal Writing in the Context of Student Abilities					
Engages students in formal science writing	0.291	0.205	0.041	**0.593**	-0.018
Engages students in recursive writing	-0.075	-0.002	0.041	**0.522**	-0.127
Addresses different levels of language proficiency	0.042	0.056	-0.144	**0.596**	0.075
Teaches students writing to learn strategies	-0.049	0.444	0.091	**0.571**	0.053
Teaches students self monitoring for understanding	0.069	0.088	0.229	**0.506**	0.275
Teaches students to be aware of learning strengths or challenges	0.166	0.03	0.041	**0.522**	-0.127
Promotes executive control of learning	0.379	-0.187	0.115	**0.541**	0.091
Assessing Students and Modifying Instruction					
Provides supplemental resources	-0.061	-0.149	0.191	**0.392**	**0.345**
Assess students prior knowledge	0.034	0.202	-0.058	0.034	**0.556**
Modifies instruction based on prior knowledge	0.046	0.068	0.104	0.032	**0.53**
Provides feedback with an academic focus	0.247	0.064	**0.347**	**0.334**	**0.355**

Using the DiISC

Observer Training

Before using the DiISC observers must be trained. Training is an iterative process and should consist of a series of steps that will result in a high degree of consistency across observers. The first step in training should be an in-depth conversation about the meaning of each item and the overall meaning of the scales. Discussion is necessary first steps to avoid individual interpretations of items that can affect inter rater reliability. The second step in training should be observation sessions in which observers watch videotapes of science lessons together and practice using the DiISC to score the teachers' instructional strategies. After all observers have finalized their scores, the ratings should be discussed as a whole group. The discussion should serve to further clarify the meanings of the items and to determine the number of additional video practice sessions that are needed before the observers are ready to go into classrooms. The amount of video practice depends on the skills of the observers and the degree to which the observers can identify the instantiation of the items when they are used as instructional strategies by teachers.

The next step is making classrooms observations with pairs of observers. Several classroom observations should be conducted in pairs with one novice and one experienced researcher or observer. After the classroom observations, ratings should be discussed in pairs and each pair of observers should come to agreement on the rating for each item. The team of observers should also meet as a group to discuss the experience of making classroom observations and the degree to which initial observations were in agreement. Paired observations should be continued until there is little need to reconcile the differences in scores between the two observers. Once it is clear that all observers understand the meaning of the items, can recognize the presence or absence of an instructional strategy, and inter rater reliability is high, observers are ready to make classroom observations on their own.

No single lesson can possibly capture all of the instructional strategies that the DiISC measures. Nor, can a single observation be a true measure of a teacher's use of instructional strategies. Consequently, we recommend that observers make at least three observations and that an average of the scores used to represent the teacher. The average score should also be used in subsequent analysis (e.g. correlating DiISC scores with student achievement).

In addition, we recommend making sure that observers have obtained the background and demographic information called for on the first page of the DiISC. The entries in this section of the DiISC include questions that help identify the characteristics of the teacher being observed. It is also helpful to make notes in the space provided about the classroom context and to describe the activities being observed. The data recorded in these sections provides information that is useful for reconciling observation scores and can also be used in subsequent data analysis.

DiISC Scales with Examples and Non-Examples

To help observers understand what each item on a scale is measuring, we provide a series of examples and non-examples to serve as a starting point for discussions in the first step in observer training. (Scales start on next page)

Inquiry Scale

This scale measures the degree to which teaching takes place in a student-centered classroom where students are engaged in hands-on activities to explore the natural world with varying degrees of investigative independence. This scale has 6 items (items 1-6). Table 3 provides examples and non-examples of *Inquiry* instructional strategies.

Table 3: Examples and Non-Examples of *Inquiry* Instructional Strategies

Items	Examples	Non-Examples
1. Creating an environment that supports inquiry	• There is hands-on exploration and data analysis • Activities support conceptual understanding	• Hands-on activities do not support inquiry (e.g. cutting shapes)
2. Asking questions	• The teacher engages students in formulate questions about the natural world • The focus is on explanations for questions • Activities distinguish between scientific and non-scientific questions	• Fact recall questions • Non-scientific questions (e.g. Is the Jerome Hotel haunted?) • Answers do not require explanations
3. Designing and planning exploration of the natural world	• Scientific investigations planned and conducted by individuals or in groups • Opportunities to justify procedures before investigations	• Teacher provides the procedures • Students follow procedures without any questioning or discussion
4. Using data to explain the results of scientific exploration (I)	• Activities include making observations and recording data • Teacher requires data to be presented in logical forms that show patterns and/or connections	• No data collection • No requirements for graphical displays of data
5. Using data to explain the results of scientific exploration (II)	• Teacher asks students to make claims, provide evidence, and develop explanations • Teacher asks students to revise explanations and models using data and logic • Teacher provide opportunities for making predictions and building models	• Teacher tells students what they are to conclude • No predictions before activities • No model building using data after activities
6. Generating scientific arguments	• Discussions encourage thinking of other ways to interpret data using scientific knowledge and logic to generate scientific arguments • Discussions identify limits and exceptions of interpretations • Discussions explore the effects of error on results and suggest ways to reduce error	• Discussions are focused on a single explanation or claim • Discussions emphasize certitude

Oral Discourse Scale

This scale measures the degree to which teaching bridges everyday experiences and scientific discourse by providing students with opportunities to build scientific vocabulary and engage in peer-to-peer discussions. These discussions lead to building scientific explanations and exploring the nature of scientific communication (i.e., a scientific classroom discourse community). This scale has 5 items (items 7-11). Table 4 provides examples and non-examples of *Oral Discourse* instructional strategies.

Table 4: Examples and Non-Examples of *Oral Discourse* Instructional Strategies

Items	Examples	Non-Examples
7. Promoting discourse through questioning	• Questions require analysis and comparison • Questions are divergent and have multiple possible answers • Questions redirect for more information, to evaluate answers, and to uncover students' reasoning	• Questions are convergent • Questions can be answered with a few words • Questions do not ask for reasons or evaluation
8. Promoting peer-to-peer discussion	• Teacher organizes small group discussions for negotiation of meaning • Teacher monitors student participation in groups • Teacher facilitates large group discussion	• No peer-to-peer discussion • Discussion elicit multiple viewpoints that must be negotiated
9. Bridging between everyday experiences and scientific discourse	• Teacher is sensitive to gender issues of discourse • Instruction connects everyday and scientific discourse • Teacher distinguishes between everyday meaning of words and their scientific meanings	• Discussions and group roles reflect gender stereotypes • Everyday experiences and vocabulary not related to scientific discourse
10. Modeling scientific discourse and vocabulary	• Teacher models how to use scientific terminology • Teacher models how to use logical connectives (why-because) • Teacher models how to argue from evidence, compare, and analyze	• Teacher does not use scientific terminology or model the forms of scientific arguments
11. Engaging students in discussion that emphasizes the nature of science	• Teacher provides opportunities to explore tentative and fallible nature of science • Teacher promotes skepticism and openness when discussing results and methods • Teacher provides opportunities for public sharing of knowledge	• Discussion focuses on facts • Teacher presents science as truth or certitude • No opportunities for public sharing of knowledge

Writing Scale

This scale measures the degree to which teaching provides students with opportunities to use science notebooks, pre-write, write, share writing, write in a variety of genres, and use language patterns and vocabulary to communicate scientific ideas. This scale has 6 items (items 12-17). Table 5 provides examples and non-examples of *Writing* instructional strategies.

Table 5: Examples and Non-Examples of *Writing* Instructional Strategies

Items	Examples	Non-Examples
12. Writing in a variety of genres	• Writing addresses different audiences and purposes • Writing is expository, reflective, and expressive • Writing reflects the nature of science	• Writing has a single format and purpose • Writing does not address the tentative fallible nature of science
13. Engaging in prewriting	• Teacher uses brainstorming strategies to create concept maps • Time is provided to develop questions and outlines • Taking notes is part of an inquiry investigations	• Teacher assigns writing activities without thinking planning, and organizing activities
14. Engaging in recursive writing processes	• Writing is reviewed and revised through multiple drafts • Teacher provides opportunities for peer-to-peer editing • Rubrics that guide revision	• Writing activities are single drafts • No feedback for revisions or rewriting • Teacher is the only source of feedback
15. Writing to acquire the language patterns and vocabulary to communicate scientific ideas	• Scientific terminology is used in writing • Language patterns of science used in writing • Language pattern models provided	• Non scientific patterns and vocabulary used to communicate in science
16. Providing direct instruction in writing content, forms, and processes	• Teacher provides instruction about the nature of scientific writing • Teacher provides templates for each genre • Teacher explains function and appropriate use of genres	• Writing takes place but there was no evidence of instruction or templates • Writing is in a single genre
17. Engaging students in using science notebooks	• Notebooks are used as a learning tool • Teacher provides instruction about how to use and organize science notebooks • Notebooks are used to record data, reflections, and/or handouts	• Notebooks are not use • Notebook is used only as a place to store worksheets • There are no specific guidelines for using notebooks

Academic Language Development Scale

This scale measures the degree to which teaching provides opportunities for students to acquire scientific vocabulary by building on students' language and culture; and using clear instruction, visual aids, and supplemental resource materials. It also measures instruction for student interactions and academic learning strategies. This scale has 8 items (items 18-25). Table 6 provides examples and non-examples of *Academic Language Development* instructional strategies.

Table 6: Examples and Non-Examples of *Academic Language Development* Instructional Strategies

Items	Examples	Non-Examples
18. Providing opportunities for students to acquire vocabulary	• There is reviewing and repetition of vocabulary • There are opportunities for building academic language from the vernacular • There are opportunities for interpreting words from contextual clues	• New or scientific vocabulary is not reinforced • Links between the vernacular and scientific vocabulary absent • Teacher does not identify contextual clues
19. Using clear instruction by modeling expectations	• Teacher varies speech and enunciates clearly • Teacher explicitly defines content and language objectives of the lesson • Teacher gives simplified directions gestures	• Directions are unclear • Directions are overly wordy and complicated • Directions do not address content and language objectives
20. Using visual aides and gestures	• Teacher uses visual imagery and organizers (thematic boards, word wall displays, concept maps) • Teacher employs gestures • Teacher uses manipulatives for abstract and concrete concepts	• Visual organizers and manipulatives are not used • Gestures do not convey instructions or procedures
21. Building lesson on students' language and culture	• Lesson includes culturally-relevant examples • Lesson includes home language when appropriate • Lesson includes cultural artifacts	• Lessons use culturally unfamiliar examples and artifacts • Home language is never used
22. Addressing multiple levels of academic language proficiency	• Teacher provides activities of varying academic linguistic demands • Teacher uses assessments that match academic language proficiency • Teacher adjusts pedagogy to the language proficiency	• Activities, assessment, and pedagogy have only one level of linguistic demands for all students
23. Provides instruction for using academic learning strategies	• Teacher provides instruction in summarizing and organizing information • Teacher provides instruction for learning strategies that support understanding (taking notes, mnemonics)	• Teacher does not teach academic learning strategies • Teacher does not indicate what strategies should be applied to specific learning tasks

Table 6: *Continued*

Items	Examples	Non-Examples
24. Provides instruction for interactions among students	• Teacher provides instruction for group work (define roles, collaborative structure, norms of behavior, inclusive interactions) • Teacher provides instruction for using collaborative inquiry skills • Teacher makes individual and group accountability clear	• Teacher assumes students know how to work in groups collaboratively • There is no mechanism for individual or group accountability • No reminders in classroom about collaborative norms
25. Uses supplemental resource materials	• Teacher provides supplemental materials (i.e., trade books) • Teacher provides access to reference materials • Teacher uses technology to support language development	• No supplemental or reference materials visible in the classroom • Students use only one textbook • Technology is used for data gathering and analysis but does not include language prompts or clues

Learning Principles Scale

This scale measures the degree to which the teaching reflects learning principles. This includes providing opportunities for students to assess prior knowledge, make conceptual connections, and engage in metacognition. The teacher also models thinking, establishes community norms, and promotes an academic focus that supports learning science. This scale has 11 items (item 26-36). Table 7 provides examples and non-examples of *Learning Principles* instructional strategies.

Table 7: Examples and Non-Examples of *Learning Principles* Instructional Strategies

Items	Examples	Non-Examples
26. Accessing prior knowledge	• Teacher helps students access their prior knowledge • Prior knowledge compared with normative ideas in science • Ideas and conceptions revised	• Lesson begins without determining what students already know
27. Modifying instruction	• Teacher identifies alternative conceptions • Teacher revises instruction based on students' understanding • Teacher uses conceptual change strategies	• Lesson begins without determining alternative conceptions • Lessons are not modified to address alternative conceptions • Alternative conceptions not challenged (e.g. discrepant events)
28. Making conceptual connections	• Instruction links facts and experiences to promote patterned reasoning • Teacher provides opportunities for assimilating new information into existing frameworks • Teacher organizes knowledge around concepts	• Facts are presented in isolation without reference to previously learned concepts • Instruction does not focus on the use of facts to support reasoning • Instruction is organized around activities
29. Reviewing key concepts	• Conceptual understanding is supported by multiple representations • Concepts are linked to examples beyond the classroom • Key concepts are reviewed	• Single representations of concepts are presented • Examples beyond the classroom are not used • No review of key concepts
30. Teaching metacognition	• Teacher models thinking in analysis of tasks or learning • Teacher uses advanced organizers and/or develops graphic tools • Teacher provides opportunities for elaboration and summarization of information	• Metacognition is taught out of context • Teacher does not model analysis of tasks • Teacher does not use metacognitive tools such as KWL charts

Table 7: *continued*

Items	Examples	Non-Examples
31. Teaching self monitoring for understanding	• Teacher provides opportunities to reflect on understanding, abilities, and affective states • Teacher provides opportunities to evaluate progress and quality of completed tasks • Teacher provides opportunities to identify what has and has not been learned	• Teacher does not embed metacognitive activities in lessons • Teacher does not embed reflective writing in lessons • Notebooks are not sued as a tool to evaluate progress
32. Developing awareness of strengths and weaknesses	• Teacher instructs in how to self-assess effectiveness of learning approaches • Teacher helps students understand unique learning approaches • Teacher allows students set the intensity or the speed of work	• Teacher provides assessment of the effectiveness of learning approaches • Lessons do not vary in learning approach emphases • Teacher sets the intensity and speed of work which is the same for all students
33. Promoting executive control of learning	• Teacher provides opportunities for choices and decisions about what and how to learn • Teacher provides opportunities for students organize and sequence their own activities	• Teacher decides what students will learn and how they will learn • Teacher engages all students in the same activity at the same time
34. Establishing classroom norms	• There are guidelines for respecting each other's ideas • There are clear rules and expectations for discourse to promote participation • There are opportunities for internalizing norms	• Classroom discussions or collaborative group activities do not reflect the use of classroom norms • Norms are not displayed or reinforced
35. Communicating lesson expectations	• Rubrics inform students of expectations • There are exemplars of student work • Teacher provides easy to follow guidelines	• Expectations are not communicated • There are no examples of what constitutes quality work displayed or provided as handouts • Guidelines for meeting expectations are unclear or not provided
36. Using feedback strategies	• Teacher uses both oral and/or written feedback • Teacher gives timely specific feedback • Teacher encourages student self-reflection	• No feedback on the quality of work • Feedback received too late to be useful • Feedback does not have an academic focus that encourages self-reflection

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APPENDIX A

Discourse in Inquiry Science Classrooms (DiISC)

Teacher Name: ___________________________ **Grade(s):** ______

Subject: _________________________________ **Lesson Plan Attached:** Yes No

School: __________________________________ **District:**____________________

Observer: _______________________________ **Date:** ___________ **Time:** ___________

Student Demographics (mark on continuum)

Male/Female Ratio: 100% M --------------------- 50% M/50% F ------------------------100% F

Ethnic Diversity: **Low**_____ Medium_____ High_____

ELLs: _________ ***Students with IEPs:*** ________

Brief description of classroom activity, classroom features, other significant information

(I) Inquiry Scale
This scale measures the degree to which teaching takes place in a student-centered classroom where students are engaged in hands-on activities to explore the natural world with varying degrees of investigative independence.

1. Teacher creates an environment that supports inquiry	**Observed:** 0 1 2 3
Teacher provides students with: a) guidelines and time for (hands-on) exploration b) tools and techniques for analysis of data c) opportunities to elaborate on conceptual understanding	**Rubric:** *0= teacher lecture, vocabulary worksheet; 1= low level inquiry, directed, convergent activity; 2= medium, somewhat divergent; 3= high, open-ended exploration*
2. Teacher engages students in asking scientific questions for the purpose of investigation (hands-on or other means)	**Observed:** 0 1 2 3
Teacher provides students opportunities to: a) formulate questions about the natural world b) present explanations for questions c) distinguish between scientific and non-scientific questions	**Rubric:** *0= teacher generates question or no investigation; 1= limited opportunity, rote, cookbook activity; 2= students directed to form scientific questions to be investigated; 3= students form and explain reasoning behind the scientific questions for their investigation*
3. Opportunities for students to design and plan exploration of the natural world individually or in groups	**Observed:** 0 1 2 3
Teacher provides opportunities and guidance to: a) plan and conduct scientific investigations individually b) plan and conduct scientific investigations in groups c) justify procedures before carrying out investigations	**Rubric:** *0= no activity or activity has a set procedure; 1= students are all expected to design the same procedure; 2= students design a procedure but are not required to justify; 3= students design, plan, and justify their approach to exploration of a topic*
4. Opportunities for early stages of scientific exploration: making observations, recording data, and constructing logical representations (e.g., graphs)	**Observed:** 0 1 2 3
Teacher provides opportunities to: a) make observations through doing the activity b) record and use data c) record and represent data in logical forms that show patterns and/or connections	**Rubric:** *0= no exploration; 1= limited opportunity to engage in exploration; 2= students collect and/or manipulate data; 3= extensive exploration*
5. Opportunities for later stages of scientific exploration: explaining phenomena via claims and evidence, making predictions, and/or building models	**Observed:** 0 1 2 3
Teacher provides students opportunities to: a) make claims, provide evidence, and develop explanations b) revise explanations and models using data and logic c) make predictions and build models	**Rubric:** *0= no use of data for scientific explanation; 1= teacher-led, incidental use of claims and evidence; 2= students generate scientific explanation and/or models; 3= includes all of 2 and teacher directs students to evaluate their scientific explanations and revise*
6. Generating scientific arguments and constructing critical discourse about limits and sources of error	**Observed:** 0 1 2 3
Teacher provides students opportunities to: a) think of other ways to interpret data using scientific knowledge and logic to generate scientific arguments b) identify limits and exceptions of interpretations of data c) discuss the effects of error on results and suggest ways to reduce error in collecting data	**Rubric:** *0= no evaluation of scientific arguments or conclusions; 1= teacher provides possible sources of error in their investigations; 2= students generate sources of error and alternative explanations are generated; 3= students are directed to revise and evaluate their scientific explanations, consider alternative explanations, and sources of error*

(OD) Oral Discourse Scale

This scale measures the degree to which teachers bridge everyday experiences and scientific discourse by providing students with opportunities to build scientific vocabulary and engage in peer-to-peer discussions that lead to building scientific explanations and exploring the nature of scientific communication (i.e., a scientific classroom discourse community).

7. Teacher promotes discourse through questioning	**Observed: 0 1 2 3**
Teacher asks questions: a) that require analysis and comparison b) that are divergent and have multiple possible answers c) to redirect for more information, to evaluate answers, and to uncover students' reasoning	**Rubric:** *0= no questioning; 1= teacher conducts IRE with convergent questions; 2= teacher asks divergent questions but doesn't engage all students in the discussion; 3= teacher probes for understanding and directs student-to-student discourse.*
8. Teacher promotes peer-to-peer discussion	**Observed: 0 1 2 3**
Teacher: a) provides opportunities for small group discussion and negotiation of meaning with specific questions or tasks b) monitors student participation in groups c) facilitates large group discussion among students or student presentation	**Rubric:** *0= no student-to-student talk; 1= teacher allows students to talk; 2= teacher monitors students' discourse; 3= teacher structures student interactions to promote rich peer-to-peer discussion*
9. Teacher (or instruction) bridges everyday experiences and scientific discourse	**Observed: 0 1 2 3**
Teacher: a) is sensitive to gender issues of discourse (using topics of interest to all students) b) connects everyday (e.g., pop culture) and scientific discourse c) distinguishes between everyday meaning of words and their scientific meanings	**Rubric:** *0= teacher just talks about science with no links; 1= teacher gives examples that not all students relate to; 2= teacher provides clear and relatable examples and makes connections to science; 3= teacher extends and builds on example(s) ensuring understanding*
10. Teacher models scientific discourse and vocabulary	**Observed: 0 1 2 3**
Teacher models how to: a) use scientific terminology b) use logical connectives in explanations (why-because) c) argue from evidence, compare, and analyze	**Rubric:** 0= no modeling; 1= teacher uses but doesn't explain scientific vocabulary or discourse; 2= teacher uses scientific vocabulary or discourse and explains meaning; 3= teacher's direct instruction explicitly models the use of scientific discourse and structure
11. Teacher engages students in discussion that emphasizes the nature of science	**Observed: 0 1 2 3**
Teacher provides students with opportunities to: a) discuss that science is tentative and fallible b) discuss results and methods (replication of experiments) with skepticism and openness c) engage in public sharing of knowledge (incorporating NOS)	**Rubric:** 0= no discussion of NOS; 1= teacher transmission of information about NOS; 2= whole group or small group discussion of NOS; 3= teacher facilitates in-depth discussion of the NOS with whole group

(W) Writing Scale

This scale measures the degree to which teachers provide students with opportunities to pre-write, write, and share their writing in order to acquire the language patterns and vocabulary to communicate scientific ideas, use science notebooks, and write in a variety of genres. Writing supports the development of a scientific classroom discourse community.

12. Formal writing in a genre that reflects the nature of science	**Observed: 0 1 2 3**
Teacher provides students with opportunities to: a) write for different audiences and purposes b) use expository, reflective, and expressive formats (e.g., newspaper article, poster, a lab report / scientific investigation report) c) emphasize the nature of science	**Rubric:** *0= no formal writing; 1= writing is unstructured or simply restated from text; 2= teacher provides a limited data set to students to write with a purpose; 3= teacher provides students a clear structure incorporating high level of inquiry, specific audience, and reflects the NOS*
13. Engaging students in <u>prewriting</u> associated with science concepts	**Observed: 0 1 2 3**
Teacher provides opportunities for students to: a) use brainstorming strategies and/or create concept maps b) develop questions and outlines c) take notes and/or use scientific terminology or symbols during scientific inquiry investigations	**Rubric:** *0= no writing;1= teacher promotes general note-taking; 2= teacher provides a structure for note-taking; 3= teacher has students generate their own ideas for the purpose of formal writing*
14. Engaging students in recursive writing processes using rubrics to review and revise	**Observed: 0 1 2 3**
Teacher provides time and opportunities for students to: a) review and revise through multiple drafts b) engage in peer-to-peer editing c) use rubrics that guide revision * Homework does not qualify here.	**Rubric:** *0= feedback provided but no revision of student work; 1= minimal time provided and students revise without a rubric; 2= students use rubrics to revise their writing; 3= students revise through either teacher feedback and/or peer editing with the use of rubrics*
15. Engaging students in writing to acquire the language patterns and vocabulary to communicate scientific ideas	**Observed: 0 1 2 3**
Teacher provides opportunities for students to use: a) scientific terminology and/or symbols or equations b) language patterns of science c) structural patterns of scientific writing (e.g., claims-evidence)	**Rubric:** *0= no writing by students; 1= minimal use of writing by students, note-taking; 2= students have the opportunity to write scientifically; 3= teacher monitors students as they engage in scientific writing*
16. Teacher provides direct instruction in writing content, forms, and processes	**Observed: 0 1 2 3**
Teacher: a) provides instruction about the nature of scientific writing b) provides templates for each genre (lab report, brochure) c) explains function and appropriate time to use genres	**Rubric:** *0= no direct instruction about how to write scientifically; 1= teacher provides template for how to write; 2= teacher explains why and when a scientific form is to be used; 3= teacher models how students would use a specific genre of writing*
17. Engaging students in using science notebooks as a learning tool	**Observed: 0 1 2 3**
Teacher provides instruction in how, or opportunities, to: a) use notebooks as a learning tool b) organize science notebooks c) record data, reflections, and/or handouts	**Rubric:** *0= no use of science notebooks; 1= student work (e.g., worksheets) pasted in notebooks with no elaboration; 2= students record data in notebooks, reference past activities, etc.; 3= students synthesize and/or revise work from their notebooks*

(ALD) Academic Language Development Scale
This scale measures the degree to which teachers use visual aids, supplemental resource materials, clear instruction throughout the lesson, and lessons that build on students' language and culture. It also measures instruction for student interactions and academic learning strategies and opportunities for students to acquire scientific vocabulary.

18. Providing students opportunities to acquire vocabulary	**Observed: 0 1 2 3**
Teacher provides opportunities for: a) reviewing and repetition of vocabulary and tasks b) building academic language from the vernacular c) interpreting words from contextual clues	**Rubric:** *0= teacher does not provide vocabulary building opportunities; 1= students are given incidental, unstructured opportunities; 2= teacher provides structured opportunities for students to acquire vocabulary; 3= teacher monitors students for understanding of vocabulary as they perform tasks*
19. Teacher uses clear instruction throughout lesson by modeling expectations	**Observed: 0 1 2 3**
Teacher: a) varies speech and enunciates clearly b) explicitly defines content and language objectives of the lesson c) gives simplified directions	**Rubric:** *0= teacher's directions are unclear and confusing; 1= clear directions, but objective is vague; 2= teacher provided clear objectives and directions; 3= teacher monitors for understanding of objectives and directions*
20. Using visual aids and gestures to communicate with students	**Observed: 0 1 2 3**
Teacher: a) uses visual imagery, organizers (e.g., thematic boards, word wall displays, concept maps) b) employs gestures c) uses manipulatives for abstract and concrete concepts	**Rubric:** *0= teacher does not use visual aids or gestures; 1= minor use of a visual aid or gestures; 2= consistent use of gestures and/or visual aids or a well-developed example of a specific visual or manipulative; 3= teacher monitors understanding of visual aids and/or manipulatives*
21. Building lesson on students' language *(vernacular or non-English)* OR culture	**Observed: 0 1 2 3**
Teacher incorporates into instruction: a) culturally-relevant examples (family, pop culture, ethnic traditions) b) native language when appropriate c) cultural artifacts (*anything human-made*) and community resources (*eating rice & beans, force on tortilla press, force on toes of a ballerina*)	**Rubric:** *0= teacher does not incorporate links to language or culture; 1= minor use of students' language or culture; 2= teacher bridges students' language and culture consistently through lesson; 3= lesson is planned and executed using familiar language with culturally relevant links to science content*
22. Teacher addresses multiple levels of academic language proficiency *(differentiated instruction and/or assessment)*	**Observed: 0 1 2 3**
Teacher: a) provides activities of varying academic linguistic demands b) uses assessments that match academic language proficiency c) adjusts pedagogy to the language proficiency * If organization is unclear, be sure to ask teacher how lesson was differentiated for students.	**Rubric:** *0= one lesson delivered the same way to all students; 1= teacher allows for students to self-pace using same set of activities; 2= differentiated assessments or projects are provided to accommodate students' various levels of academic language proficiency; 3= teacher organizes individual students' activities based on their academic language proficiency*
23. Provides direct instruction for using academic learning strategies	**Observed: 0 1 2 3**
Teacher provides instruction in: a) summarizing b) organizing information for understanding (taking notes, data organization, mnemonics) c) making inferences from data (evidence supported)	**Rubric:** *0= teacher provides no direct instruction; 1=teacher mentions in passing that students might use an academic learning strategy; 2= teacher models how to use a specific strategy for students to use; 3= teacher models and monitors students in using the strategy*

24. Teacher provides instruction for interactions among Students	**Observed: 0 1 2 3**
Teacher provides instruction in: a) how the groups will be organized and function (defines roles, collaborative structure, social norms of behavior in a group, inclusive interactions) b) using collaborative inquiry skills (how to paraphrase and ask questions for clarification) c) structures of accountability (academic and socially as a group)	**Rubric:** *0= teacher does not give instruction for how groups will be organized; 1= teacher directs students to work together; 2= teacher provides roles for students within groups; 3= teacher provides roles and establishes individual accountability within each group and monitors activity.*
25. Uses supplemental resource material ***(Note: lesson could be done without these)***	**Observed: 0 1 2 3**
Teacher: a) provides supplemental materials (e.g., trade books) b) provides access to reference materials (e.g., bilingual dictionary) c) uses technology to support language development (e.g., Internet)	**Rubric:** *0= no supplemental resources are available to students; 1= student independently uses an additional resource; 2= teacher directs students to use supplemental resources; 3= teacher models use of supplemental resource(s)*

(LP) Learning Principles Scale

This scale measures the degree to which the teacher aligns lessons with the CISIP model. This includes providing opportunities for students to assess prior knowledge, make conceptual connections, and engage in metacognition. The teacher also models thinking, establishes community norms, and promotes an academic focus that supports learning science.

26. Accessing students' prior knowledge	**Observed: 0 1 2 3**
Teacher provides students opportunities to: a) access their prior knowledge b) compare prior knowledge with normative ideas in science c) reflect and/discuss initial ideas and conceptions Note: Accessing prior knowledge means determining what students know before teaching the unit, oral or written.	**Rubric:** *0= lesson is delivered without determining what students know about the concept(s) to be studied; 1= teacher conducts an informal survey of the class but doesn't direct all students to self-assess; 2= teacher directs all students to determine what they know on a topic before starting the lesson; 3= lesson involves a comparison of students' prior knowledge with normative ideas*
27. Teacher modifies instruction based on students' prior knowledge	**Observed: 0 1 2 3**
Teacher: a) identifies alternative conceptions b) revises instruction based on students' understanding c) uses conceptual change strategies * If teacher's degree of modification is unclear, be sure to ask teacher how lesson was changed from original plan.	**Rubric:** *0= teacher doesn't make any modifications based on students' prior knowledge; 1= teacher identifies students' prior conceptions and minimally addresses them; 2= teacher revises original lesson to accommodate students' level of understanding; 3= teacher uses pro-active conceptual change strategies (e.g., a discrepant event) to shift students prior conceptions*
28. Teacher and/or students situate factual knowledge (experiences, ideas, data, and explanations to past lessons and/or real-world experiences) within a conceptual framework *(fact to concept relationship)*	**Observed: 0 1 2 3**
Teacher provides opportunities to: a) link facts and experiences to promote patterned reasoning b) assimilating new information into existing frameworks of past lessons and real-world experiences c) place factual knowledge in a conceptual framework	**Rubric:** *0= no conceptual framework utilized, just factual information; 1= teacher provides informal opportunities for students to generate understanding of topics; 2= teacher provides formal structure for generating understanding of facts within a conceptual framework; 3= teacher provides opportunities and monitors student understanding*
29. Teacher provides opportunities for students to review key concepts *(focus on the review, not the discourse)*	**Observed: 0 1 2 3**
Teacher provides opportunities for conceptual understanding: a) through multiple and rich representations b) by linking formal science to ideas beyond the classroom c) by reviewing key concepts	**Rubric:** *0= teacher does not provide opportunities for reviewing concepts; 1= teacher provides informal review of key concepts; 2= teacher provides formal opportunities for reviewing; 3= teacher provides multiple formal opportunities for reviewing*
30. Teaching with embedded metacognition for students to elaborate and summarize their understandings	**Observed: 0 1 2 3**
Teacher: a) models thinking in analysis of tasks or learning b) provides advanced organizers and/or develops graphic tools c) provides opportunities for students to elaborate and summarize	**Rubric:** *0= no opportunity for students to engage in connected metacognitive activity with the science concepts they are learning; 1= students have the opportunity to summarize what they have learned; 2= students have the opportunity to distinguish what they do and don't understand in a structured activity; 3=students have the opportunity to reflect metacognitively and define methods to expand their understanding*

31. Teaching self-monitoring for understanding *(focus on direct instruction of strategies)*	**Observed: 0 1 2 3**
Teacher directly instructs students how to: a) reflect on their understanding, abilities, and affective states b) evaluate their own progress and quality of completed tasks c) identify what they have and have not been learned	**Rubric:** *0= teacher provides no direct instruction of strategies for student awareness of what they know and don't know or what resources they could use to find out; 1= teacher instructs students how to summarize what they have learned; 2 = teacher instructs students how to distinguish between what they know and what they don't know; 3= teacher instructs students how to reflect metacognitively and define methods to expand their understanding*
32. Teacher provides students opportunities to develop awareness of their own learning strengths and challenges	**Observed: 0 1 2 3**
Teacher provides opportunities for students to: a) self-assess effectiveness of their learning approaches b) understand unique learning approaches c) set the intensity or the speed of work Note: Focus on learning approaches	**Rubric:** *0= no opportunities provided; 1= students are allowed to self-pace work; 2= students are directed to evaluate their learning approaches to the task at hand; 3= teacher provides resources to self-assess their strengths and challenges*
33. Promoting executive control of learning *(student choice about what and how they learn)*	**Observed: 0 1 2 3**
Teacher provides opportunities for students to: a) make choices and decisions about what and how to learn b) recognize that learning is under their control c) organize and sequence their own activities	**Rubric:** *0= students are not given a choice of activities; 1= students are allowed to self-pace the activities provided for them; 2= students have a choice of activities to choose from; 3= students generate their own activity focus*
34. Teacher establishes or reminds students of community norms for discourse	**Observed: 0 1 2 3**
Teacher: a) negotiates, or reminds students of, guidelines for respecting each other's ideas b) establishes clear rules and expectations for discourse to promote everyone's participation c) provides opportunities for internalizing norms	**Rubric:** *0= community norms for scientific discourse are not in place or being generated; 1= teacher has community norms posted in the classroom; 2= teacher refers to classroom norms to remind students and promote equitable participation; 3=teacher involves students in establishing or maintaining community norms*
35. Communicating lesson expectations with guidelines *(oral or written)*, or rubrics, or exemplars	**Observed: 0 1 2 3**
Teacher: a) uses rubrics to inform students of performance expectations b) provides exemplars of student work 1c) provides easy to follow guidelines	**Rubric:** *0= no communication of teacher expectations; 1= general guidelines & performance expectations only; 2= specific guidelines & performance expectations with rubrics; 3= specific guidelines & performance expectations with rubrics and exemplars*
36. Teacher uses feedback strategies that have an academic focus *(NOT just praise; "be more specific")*	**Observed: 0 1 2 3**
Teacher: a) uses both oral and/or written feedback b) give timely feedback c) encourages student self-reflection	**Rubric:** *0= teacher does not provide students with any feedback; 1= teacher provides minor feedback; 2= teacher provides sufficient feedback that encourages students to reconsider their ideas; 3= uses multiple forms of feedback*

APPENDIX B

Resources

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