

CRITICAL COMPONENTS: DEFINITIONS AND EXPLANATIONS

“Critical components” are the elements of an instructional materials program that are essential to its implementation. They are the variables one must measure in order to determine fidelity of implementation of programs and in turn, their efficacy. Likewise, they are the variables one must identify and measure in order to engage in studies that rigorously compare instructional materials programs and their relative effectiveness. Clearly articulating the critical components of an instructional materials program model is a key part of the process of accurately measuring FOI.

CEMSE’s FOI Framework provides a structure for organizing intervention critical components. It comprises two main categories, each with two sub-categories. Structural Critical Components reflect the developers’ decisions about the design and organization of the materials. In the “Structural” category, *procedural* critical components indicate the step-by-step actions a teacher is expected to take. In other words, they focus on what the teacher needs to *do* to enact the intended program. The *educative* critical components, on the other hand, represent what the teacher needs to *know* in order to enact the intended program. Instructional Critical Components, on the other hand, reflect the developers’ expectations for the enacted classroom instruction. In the “Instructional” category, *pedagogical* critical components reflect the developers’ intentions about the instructional transactions. In other words, they identify beliefs about the instructional strategies the teacher needs to employ and interactions the teacher needs to have with students in order to appropriately use the program. Similarly, there are *student engagement* critical components that reflect the developers’ expectations for student behaviors and interactions with one another and the teacher during instruction.

Identifying the critical components of a program and organizing them into categories as described above is an essential part of rigorously measuring FOI of that program. As a starting point for this process, we have identified critical components that are present across multiple mathematics and science instructional materials programs. In addition to these shared critical components, there are also some critical components that are unique to particular programs.

Additionally, there are some program elements that developers may not deem “critical” to the implementation of the program but still believe they can contribute to student learning. We refer to this as “contributing program elements” and mark them with an asterisk.

Finally, it is important to acknowledge that classrooms are complex environments and that some critical components – in particular, the instructional critical components – do not exist in isolation from one another. We have identified them as separate variables and have identified separate indicators for each in our instruments. However, we recognize that many of them cannot be isolated. For example, in a classroom environment, one can only determine that students are engaging in “intellectually challenging work” if students “communicate.” Thus, these two critical components, while distinct in themselves, are clearly related.

Below are descriptions of each of the common critical components.

Structural/Procedural

Common to Mathematics and Science

1. **Duration of Unit:** The length of time in weeks that a unit is taught. The time period starts with the beginning of the first **class session** of the unit and goes to the completion of the unit’s last class session.
2. **Time Spent on Instruction:** The amount of time spent on instruction. This is the quantification of class time spent on teaching the program. Programs often specify it as the amount of minutes a

lesson or portion of a lesson is intended to last.

3. **Investigation/Lesson Order:** The specified sequence of lessons in the unit. Most programs offer explicit or implicit indications that the lessons conceptually build on one another and therefore should be taught in a particular order.
4. **Order of Segments and Parts within a Lesson:** The specified order of lesson segments and parts within those segments. Most programs offer explicit or implicit indications that the lessons conceptually build on one another and therefore should be taught in a particular order.
5. **Inclusion of All Essential Segments within a Lesson:** The presence of all essential segments of a lesson. The *segments* of the lesson are the organizational sections. The enactment of some specific parts that take place within a lesson segment (e.g. writing structures, homework, extensions) are measured elsewhere **in the instruments**. The instruments can be adapted to include elements of the lesson that are smaller than segments if users are interested in more specific data on enactment of other parts of the lesson.
6. **Inclusion of All Essential Lessons:** The required lessons in a unit. In some programs, *all* lessons are considered to be required while other programs indicate that some lessons are required and others are optional.
7. **Lesson Overview:** Teacher reading or review of the portion of the lesson that provides specific information about what students will do during the lesson, the content they will learn, and the materials they will use. It does not include lesson preparation, which is addressed in another critical component.
8. **Lesson Preparation:** Teacher reading, review, and/or enactment of the preparation that is required directly before the lesson. This includes any materials management and organization that is specified in the lesson. Other lesson preparation that is not specified in the lesson is accounted for as a moderating variable.
9. **Materials Presence:** The presence of the materials, manipulatives, and tools required in the lesson, unit, or program in the classroom.
10. **Writing Structures:** Teacher use of the writing structures specified in the instructional materials. “Writing Structures” include the range of writing formats and tools included in the programs such as individual pre-formatted sheets and assembled notebooks or journals for students to use.
11. **Readings:** Teacher use of the readings in the instructional materials. Depending on the program, readings can include books with assigned text or copies of readings from the instructional materials. These are required readings and do not include any optional reading resources that may be specified in lesson; the latter are included as contributing program elements.
12. **Assessments and Assessment Interpretation Tools:** Teacher use of the assessments and assessment tools in the instructional materials. “Assessments” include those program elements designed to measure student knowledge and include formal tests and quizzes, projects, performance tasks, informal or anecdotal assessment opportunities within lessons, and student self-assessments. The assessments vary in their level of formality, from formal tests to informal questions or work checks to assess student understanding. “Assessment tools” are those tools that help the teacher *interpret* information gathered in the assessments and include scoring guides, rubrics, checklists, and student exemplars. Assessment Interpretation Tools target specific learning goals in the materials and do not include general information on assessment strategies. General assessment information is

accounted for in the Educative category of critical components.

13. **Content of the Lesson:** The teacher addresses the content in the lesson. Content is further broken down into facts (“a triangle has three sides” or “there are 206 bones in the adult human body”), procedures (“how to solve an algebraic equation” or “how to complete a titration”), concepts (“real numbers” or “adaptation”) and processes (communicating or predicting outcomes). While these types of content are slightly different in mathematics and science, the two are grouped together in this single critical component. It is important to note that in science, procedures are very much intertwined with processes: the procedure for using a magnifier is very similar to the process skill of careful observation.
14. **Projects*:** Teacher use of projects from the instructional materials. Projects are learning activities that accompany the core lesson sequence. They can be embedded in a lesson, take place across lessons, or take place outside of regular class time, but are all designated by the program as projects.
15. **Non-Discipline-Related Extensions*:** Teacher enactment of non-discipline-related extensions from the written lessons. These are activities suggested in the materials that extend the content/focus of the lesson to other subject areas (mathematics, social studies, language arts, art).
16. **Discipline-Related Extensions*:** Teacher enactment of discipline-related extensions from the written lessons. These are activities suggested in the materials that extend the content/focus within the discipline.
17. **Additional Resources*:** Teacher uses, suggests, or makes available to students the additional resources identified in the instructional materials. Additional resources are supplemental materials recommended in the instructional materials for a particular unit. They include books, magazines, and videos. They are intended for both student and teacher use.
18. **Additional Computer/Web Resources*:** Teacher uses, suggests, or makes available to students the computer/web resources identified in the instructional materials. These include software and web resources that complement a unit or lesson and are geared towards students and/or teachers.
19. **Physical Environment Conducive to Student Learning*:** The classroom reflects the learning environment the instructional materials suggest. This includes content-related visuals, subject-related centers, and student seating arrangements that help promote student learning.

Common to Mathematics

- A. **Unit Order:** The specified order of the units within a mathematics program. In math, each unit often builds on concepts and skills from earlier units, and should therefore be taught in order. The same is not always true for distinct units in science.

Structural/Educative

Educative critical components are program elements that communicate generalizable information about content and pedagogy. If information is not generalizable – meaning, it is relevant only to the particular written lesson(s) of the program - then it falls in the procedural category (not educative). Similarly, if a teacher could have obtained the information/knowledge somewhere outside of the written materials (e.g. in a course, professional development, other written pieces), it is considered educative. Another way to think about educative components is that they are elements of the program that are “built in” professional development and are designed to teach the teacher about the content and pedagogy of high quality instruction.

Common to Mathematics and Science

1. **Background Information on Content:** The teacher consults the information contained in the unit and lesson level background on content. The unit level background details the content covered throughout the unit and tends to cover the big ideas and broader concepts of the unit as well as pedagogical content knowledge. The lesson level background details the content specific to a lesson. It often appears at the beginning of a lesson as part of an overview.
2. **Background Information on Pedagogy:** The teacher consults the information contained in the background on pedagogy. This is any information on pedagogy and includes general teaching strategies that the teacher can use while teaching the program. It is often in the front matter of the instructional materials.
3. **Assessment Background Information:** The teacher consults the information contained in the background on assessment. This is the general information on assessment, including explanations of methods of assessment, types of assessment, and how best to integrate assessment into the unit. Any specific assessments or specific assessment interpretation tools fall into the “procedural” category and not included here.
4. **National Standards and Benchmarks Information*:** The teacher consults or knows the information contained in the materials on Standards and Benchmarks. This information refers to documents such as the National Science Education Standards, the Project 2061 Benchmarks for Science Literacy, or the National Council of Teachers of Mathematics Standards. The presence of state or local standards is measured as a moderating variable.
5. **Lesson Notes:** The teacher consults the information contained in the lesson notes (both educative and procedural). These are the notes in the lesson that give the teacher information or tell the teacher what to do. Educative and procedural notes are not separated, because most of the instructional materials do not clearly distinguish between the two. Safety notes are included in the science-specific “Safety” critical component.

Common to Science

- A. **Safety:** The teacher consults the information about safety, which can be in a single place in the unit and/or included in notes. Information that is specific to a particular activity (e.g. make sure students wear goggles) and general information (e.g. don’t eat inside a lab) are both included here.

Instructional/Pedagogical

Instructional critical components include the intended teacher and student behaviors and interactions that take place during program use. The behaviors and interactions embedded in the instructional critical components (with a few exceptions) can take place at any point during a lesson, and are not bound to specific structural critical components. For example, “Teacher Facilitation of Student Discussion” can take place at many points during a lesson, embedded in several of the lesson’s structural elements.

Common to Mathematics and Science

1. **Teacher Facilitation of Group Work:** The teacher employs strategies that promote productive group interactions and learning. Small groups include partners or pairs of students. Strategies include facilitating on-task behavior, establishing guidelines and norms for group interaction, encouraging each group member to participate and ensuring that all students understand the task at hand.
2. **Teacher Facilitation of Student Discussion:** The teacher encourages and promotes the students’ discussions with one another. In this case, “discussion” is: an on-topic, substantive exchange of ideas. It can occur at any time during a lesson, but must include a back-and-forth exchange (A-B-A) (e.g. it cannot be only a student asks a question and the teacher answers). Strategies include the teacher asking students to rephrase, repeat, or respond to others’ thoughts, using appropriate wait

time, clarifying points students make, and using Think, Pair, Share or a similar strategy. In this case, “discussion” is distinguished from communication in that discussion is a social process, whereas communication need not include interactions between two or more people.

3. **Teacher Facilitation of Students Doing Intellectually Challenging Work:** The teacher helps students synthesize information and ideas, use rules of logical thinking, and draw conclusions. Questions resulting from bringing together information may be evidence of intellectually challenging work. This critical component is where many “thinking and process skills,” as they are sometimes referred to reside. Strategies include asking students to apply new knowledge to new settings, providing opportunities for students to come up with new problem-solving tactics, consider alternative arguments or explanations, hypothesize and predict, interpret their experiences, analyze data, revise ideas based on evidence, explain their reasoning, and support their conclusions with evidence.
4. **Teacher Facilitation of Students Making Connections:** The teacher helps students recognize relationships between their experiences or learning in class and other aspects of the same discipline, other disciplines, or the real world. They can be made for the purpose of supporting students’ conceptual development or for engaging their interest. Strategies include asking students what they already know about the topic of the lesson, relating the lesson to current events, to practical applications, or to the content of previous lessons, and asking students to identify relationships between lesson content and other aspects of the discipline.
5. **Teacher Facilitation of Student Communication:** The teacher helps students express ideas about the lesson content (or related content) through writing, speaking, or other representations. These ideas may be exploratory or presentational. Communication need not include more than one person (whereas “discussion” described earlier, is a social process. Strategies include asking students to express their opinions or point of view, having students do presentations, having students write down or orally express their thought processes, and providing opportunities for students to non-verbally represent their ideas
6. **Teacher Emphasis on Types of Content:** The teacher approaches the time spent on, questions asked about, and focus of depth on content in a manner consistent with the instructional materials. Instructional materials might note that certain lessons are a more appropriate fit with a focus on facts and procedures instead of concepts. The emphasis here is on the extent to which the balance is consistent with the expectations in the instructional materials.
7. **Teacher Facilitation of Student Autonomy:** The teacher helps students demonstrate independence in and ownership of their learning. Strategies include encouraging students to use the range of resources available to them to solve problems, encouraging students to move beyond their levels of comfort, validating students’ willingness to take risks, allowing students to take a leadership role in discussion and assist others in finding solutions, and providing opportunities for students to work without regulation.
8. **Teacher Facilitation of Materials, Manipulatives, and Tools Use:** The teacher uses and efficiently manages (e.g. has a distribution system in place) non-print materials, manipulatives, and tools in the classroom and ensures their proper use (e.g. model their use for students).
9. **Teacher Use of a Variety of Class Structures:** The teacher implements a *variety* of class structures (e.g. small group, whole class, partners, independent work) in the classroom both within and across class sessions. Strategies include indicating which classroom structures were present in the observed session, rating how well they were facilitated, and having the variety of class structures be consistent

with the Instructional Materials.

10. **Teacher Use of a Variety of Instructional Delivery Formats:** The teacher implements a *variety* of instructional delivery formats (e.g. learning centers, discussions, games, readings, interactions with materials) in the classroom within and across class sessions. Strategies include indicating which instructional formats were present in the observed session, rating how well they were facilitated, and having the variety of instructional formats be consistent with the Instructional Materials.
11. **Teacher Use of Assessment to Inform Instruction:** The teacher uses information about the students' current understandings of the content to shape or alter the lesson in progress or a future lesson. Other terms that often apply to this are "formative" and "ongoing assessment." Strategies include the teacher addressing misconceptions, changing instruction based on student responses, and commenting on changes in future instruction based on observations.
12. **Teacher Use of Multiple Modes of Assessment:** The teacher uses a variety of structures (e.g. independent work, whole class discussion, group work) and sources of information (e.g. observation, portfolios, written work, discussions, performance tasks) to assess learning.
13. **Teacher Use of Differentiation:** The teacher customizes instruction to special or unique needs of individuals or small groups of students in the class. Strategies include scaffolding ideas and activities for individual students, suggesting different activities based on ability or learning modality, and providing access to the full variety of activities used during a class session. Differentiation takes place to accommodate differences in characteristics of the students, as opposed to differences in their understandings of the content. This is addressed in "Teacher Use of Assessment to Inform Instruction".

Common to Science

- A. **Teacher Coordination of Reading and Science Instruction:** The teacher furthers science learning goals through reading. These are strategies the teacher may use in order to help students understand and learn from the reading (e.g. two-column notes, comprehension questions). Giving students a reading, by itself, is not sufficient.
- B. **Teacher Facilitation of Student Observation and Data Collection:** The teacher has students practice observing phenomena or using other methods to collect data. This can overlap with intellectually challenging work.

Common to Mathematics

- A. **Teacher Supports Multiple Solution Strategies:** The teacher encourages students to try different methods for solving a problem. This is different from "Intellectually Challenging Work" because the more specific strategy of fostering more than way to solve a problem is a hallmark of mathematics.

Instructional/Student Engagement

Student engagement critical components focus on expectations for students' behaviors during the enactment of the program. Some of the student engagement critical components are also desired outcomes, but in this context, they are considered essential elements of program *implementation* and the students' roles in that implementation. For example, one might identify "students engage in intellectually challenging work" as an outcome. But in this work we are not measuring their ability or increased capacity to engage in intellectually challenging work. Rather, we are measuring the extent to which they *did* (or are) engaging in that activity during the enactment of the lesson.

Some of the student engagement critical components align directly with the pedagogical critical components. For example, "Students Contribute to Group Work" aligns with "Teacher Facilitation of Group Work."

Others align more with the structural procedural critical components such as “students do/complete essential activities.”

Common to Mathematics and Science

1. **Students Contribute to Group Work:** Students participate in and equally contribute productive group interactions and learning. This includes students managing time efficiently, staying on task, and working respectfully with their peers.
2. **Students Engage in Discussion:** Students engage in on-topic, substantive exchange of with one another and the teacher. This includes responding to the teacher’s questions and attending to others’ contributions.
3. **Students Engage in Intellectually Challenging Work:** Students synthesize information and ideas, use rules of logical thinking, and draw conclusions. This includes students demonstrating reasoning, making predictions, revising ideas based on evidence, and transferring and applying knowledge to new settings. It is likely that evidence of this critical component will be coincident with discussion or communication.
4. **Students Make Connections:** Students identify relationships between their experiences or learning in class and other aspects of the same discipline, other disciplines, or the real world.
5. **Students Communicate:** Students express ideas about lesson content (or related content) through writing, speaking, or other representations. These ideas can be exploratory or presentational. Communication need only include one student.
6. **Students Demonstrate Autonomy:** Students demonstrate independence in and ownership of their learning. This includes assisting other students, moving beyond their levels of comfort in the classroom, making choices during the course of the lesson and using the range of resources available to them to solve problems.
7. **Students Do/Complete Essential Activities:** Students do or complete activities required by the instructional materials that are assigned in class. This includes readings, writing structures, assessments, and the use of materials, manipulatives, and tools.
8. **Students Do/Complete Optional Non-Essential Activities:** Students do or complete activities in the instructional materials that are assigned in class, but are considered optional. This includes home activities, disciplinary and non-disciplinary extensions, additional resources, and additional computer and web resources.

Common to Science

- A. **Students Observe and Collect Data:** Students use observation and other methods to collect data. While observation and data collection can be related to other critical components, it is possible to have students observe or collect data without being part of what we are defining as “intellectually challenging work.”

Common to Mathematics

- A. **Students Use Multiple Solution Strategies:** Students try different methods to solve a problem.

External Contexts and Conditions

The FOI project’s primary focus is the development of instruments that measure the extent to which an enacted program is consistent with its intended program model. The instruments are designed to help

researchers and practitioners answer the question: *What is the nature* of the implementation of the program in classrooms and schools?

It is important to acknowledge, however, that describing implementation comprises only a portion of what we need to know to better understand the impact that programs have on teachers and students. We also need to understand *why* the implementation happens as it does.

Many contexts and conditions, from student background to teacher experience influence the enactment of a program. Rather than describe *what* implementation is, these factors help to explain *why* implementation happens as it does. They have an impact on FOI, but do not reside within the conceptual framework we have developed to describe FOI. Thus, their comprehensive measurement is beyond the scope of this project. However, we recognize that understanding these factors is essential to developing knowledge about school improvement. Therefore, we have included items in our instruments that gather data on these contexts and conditions. However, we limited our inclusion of items addressing these variables so that they would not compromise our ability to measure FOI – our primary area of interest.

The variables we have decided to measure that reflect the contexts and conditions affecting implementation are described below:

- 1. Teacher participation in professional development**
 - a. PD - Curriculum Specific: The extent of teacher professional development experience with the program.
 - b. PD – General Pedagogy: The extent of teacher professional development experience with pedagogical strategies consistent with the program.
 - c. PD – General Content: The extent of teacher professional development experience with the science or mathematics content consistent with the program.

- 2. Prior teacher knowledge, and formal education**
 - a. Teacher's highest degree in a content area.
 - b. Teacher's highest degree in education.

- 3. Prior Teacher Experience**
 - a. Teacher's number of years teaching.
 - b. Teacher's number of years teaching the current grade.
 - c. Teacher's number of years teaching the program
 - d. Teacher's number of years teaching science/math

- 4. Teacher attitude**
 - a. The teacher's positive or negative affect toward mathematics
 - b. The teacher's positive or negative affect towards science
 - c. The teacher's positive or negative affect toward the program. This can include perceptions of ease of use and appropriateness of content (e.g. too much, or not enough detail in the teacher's guide.
 - d. The teacher's positive or negative views of professional development and other support services.
 - e. The teacher's positive or negative views of the administration including the principal and assistant principal.

- 5. Administrative support** - Verbal, financial, human, and instructional supports for program implementation.

- 6. Shared planning time** - The amount of time scheduled per week that teachers have to work with one another to discuss lessons, instruction, and content related to the program.

7. **Collaboration among teachers** – Teacher utilization of peers as resources for support with content, materials, and/or instruction.
8. **Teacher involvement in curriculum adoption process** – Teacher’s perception that he/she had a voice in the selection of the instructional materials they will use.
9. **In-school specialist** - The presence of an in-school specialist (a.k.a. resource teacher, teacher leader) who supports the teachers’ efforts to implement the program through coaching, modeling lessons, discussion instruction, etc.
10. **School-wide homework policies and practices** – The presence of homework policies that are in alignment with the program (e.g. are they supportive of the curriculum’s expectations?).
11. **Benchmark and standards policies and practices** -Teachers perceptions that there is a match between the state standards and the instructional materials (e.g. content alignment-processes, concepts, and broader content area).
12. **Class structure**
 - a. Size during lesson instruction (this documents whether the class is organized into smaller groups for particular subjects).
 - b. Grade composition (this documents the number of grades in a single classroom.)
13. **Classroom management/discipline issues**
 - a. The presence of behavior disruptions in the classroom.
 - b. The extent to which classroom management and discipline issues are handled and resolved.
14. **General Disruptions**- The presence of other interruptions during instruction, including visitor presence; announcements, calls, or messages; power outages, fire drills, or emergencies; and distracting events.
15. **Supplementation**
 - a. **Educative** – Teacher use of materials outside of the program or professional development that inform the teacher’s knowledge of content, pedagogy, or assessment.
 - b. **Structural** – Teacher use of commercial or teacher-made materials in the classroom that are not part of the program.
16. **Time**
 - a. The amount of time in the schedule for instruction on the subject.
 - b. The structure of the time (e.g. consecutive minutes).
17. **Teaching delivery structure**
 - a. **Departmentalization** The presence of a structure by which a single teacher instructs more than one class of students in a particular subject area (e.g. a science or mathematics specialist).
 - b. **Team teaching**
18. **Additional assistance in the classroom** - Classroom aide, parent, another teacher, or student volunteers present to assist the teacher.
19. **Other initiatives** - The presence of programs that augment or detract from the classroom implementation of the program.

20. **Additional Preparation** - The use of general lesson preparation strategies that are not directly from the instructional materials and their sections about lesson preparation. These strategies might include reading the lesson or other material, grouping students, or assembling materials.

Student/Classroom Characteristics

21. **English Language Learners** – The presence of any students who are English Language Learners.
22. **Special Education Students**- The presence of any students who are in Special Education.
23. **Teacher Perception of Student Ability** – The level of ability that teachers believe their students have.
24. **Bilingual or multilingual Classroom**- The presence of a classroom in which instruction occurs in more than one language.
25. **Special Education Classroom**- The presence of a classroom in which all of the students are in Special Education.