



REFORMED TEACHING OBSERVATION PROTOCOL (RTOP) WITH ACCOMPANYING DAYTON REGIONAL STEM CENTER RUBRIC

[HTTP://MATHED.ASU.EDU/INSTRUMENTS/RTOP/INDEX.SHTML](http://mathed.asu.edu/instruments/rtop/index.shtml)

The Dayton Regional STEM Center (DRSC) is a grant funded educational foundation that has assumed the responsibility of providing educators professional opportunities for growth in collaboration with Science, Technology, Engineering and Math professionals. Educators participate in a year long professional development sequence during which they intern and tour STEM industries, participate in workshops on topics such as inquiry-based learning, a STEM Quality Rubric, and collaborative learning and finally use their newly gained knowledge to develop original STEM curriculum. In order to ensure the most effective creation and implementation of the DRSC's curriculum, strong assessment criteria is paramount.

The RTOP was created as an observational tool to be used in measuring "reformed" teaching, based upon the theory of constructivism. It was developed by the Arizona Collaborative for Excellence in the Preparation of Teachers, and allows for the assessment of a specific instructional segment. The authors of the RTOP share, "Acknowledging this variety (current conceptions of constructivism), perhaps a beginning definition of a constructivist classroom would be one in which people are working together to learn. This has been called a "knowledge-building community" (Bereiter & Scardamalia, 1993, pg. 210-216). The RTOP provides an assessment of constructivist teaching, but lacks feedback for improvement in creation and delivery of the curriculum. The DRSC strongly supports the utilization of the RTOP's criteria, and has made strides to provide feedback and development suggestions on the curricular design demanded by a constructivist approach. Dr. James Rowley of the University of Dayton has developed a STEM Quality Rubric which examines principles that are unique to STEM curriculum. It specifically identifies the unquities of constructivist (STEM) education, and sets standards for successful development. Utilizing both of the assessment pieces, the DRSC is able to provide educators with immense scaffolding for planning and instructional growth.



Section 1: Background Information

Name of teacher _____

Announced Observation? (yes, no, or explain)

Location of class (district, school, room)

Years of Teaching _____

Teaching Certification (K-8 or 7-12)

Subject observed Grade level _____

Observer Date of observation _____

Start time _____

End time _____

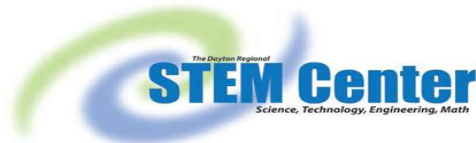


Section 2: Contextual Background and Activities

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

Record here events that may help in documenting the ratings.

Time	Description of Events



Section 3: LESSON DESIGN AND IMPLEMENTATION

1. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.

A cornerstone of reformed teaching is taking into consideration the prior knowledge that students bring with them. The term "respected" is pivotal in this item. It suggests an attitude of curiosity on the teacher's part, an active solicitation of student ideas, and an understanding that much of what a student brings to the mathematics or science classroom is strongly shaped and conditioned by their everyday experiences.

4	The students write or draw a diagram of their hypothesis, estimation or prediction and discuss it in a small group or large group setting, prior to exploration and teacher instruction.
3	The students write, draw or discuss their hypothesis, estimation or prediction prior to exploration and teacher instruction.
2	The teacher solicits information from students concerning prior knowledge of phenomenon.
1	The teacher refers to previous student experiences or relates previous learning. (no respect aspect)
0	The teacher makes no reference to prior knowledge.

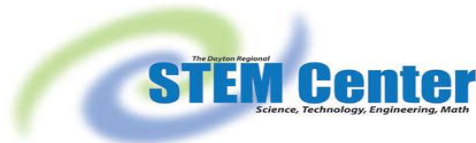
2. The lesson was designed to engage students as members of a learning community.

Much knowledge is socially constructed. The setting within which this occurs has been called a "learning community." The use of the term community in the phrase "the scientific community" (a "self-governing" body) is similar to the way it is intended in this item. Students participate actively; their participation is integral to the actions of the community, and knowledge is negotiated within the community. It is important to remember that a group of learners does not necessarily constitute a "learning community."

4	All students in the small group contribute to the construction of ideas and theory building.
3	Some students in the small group contribute to the construction of ideas and theory building.
2	There is some student-to-student interaction and discussion but little or no construction of ideas or theory building.
1	The lesson employs only large group discussion with little evidence of community. Primarily the teacher addresses the class and some students respond.
0	This lesson is completely teacher-centered, lecture only.

3. In this lesson, student exploration preceded formal presentation.

Reformed teaching allows students to build complex abstract knowledge from simpler, more concrete experience. This suggests that any formal presentation of content should be



preceded by student exploration. This does not imply the converse...that all exploration should be followed by a formal presentation.

4	The teacher presents no formal content prior to student exploration.
3	The teacher introduces formal content prior to student investigation.
2	The teacher presents the results of the student investigation prior to student exploration.
1	The teacher instruction of formal content occurs prior to student investigation.
0	No student exploration is seen.

4. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.

Divergent thinking is an important part of mathematical and scientific reasoning. A lesson that meets this criterion would not insist on only one method of experimentation or one approach to solving a problem. A teacher who valued alternative modes of thinking would respect and actively solicit a variety of approaches, and understand that there may be more than one answer to a question.

4	The teacher solicits multiple approaches to solve the problem and has students present the approaches to the large group.
3	The teacher solicits multiple approaches to solve the problem.
2	The students utilize multiple approaches to solve the problem.
1	The student investigation is teacher directed.
0	The students do no investigation or problem solving.

5. The focus and direction of the lesson was often determined by ideas originating with students.

If students are members of a true learning community, and if divergence of thinking is valued, then the direction that a lesson takes cannot always be predicted in advance. Thus, planning and executing a lesson may include contingencies for building upon the unexpected. A lesson that met this criterion might not end up where it appeared to be heading at the beginning.

4	Students generate ideas and questions. Students develop investigation.
3	Students generate ideas and questions. Students have input in designing the investigation. –or- Teacher presents problem and students design investigation.
2	The students generate ideas and/or investigation.
1	The student investigation is teacher directed.
0	The lesson is teacher demonstration.



Section 4: CONTENT (Propositional & Procedural Knowledge)

Knowledge can be thought of as having two forms: knowledge of what is (Propositional Knowledge), and knowledge of how to (Procedural Knowledge). Both are types of content. The RTOP was designed to evaluate mathematics or science lessons in terms of both.

Propositional Knowledge

This section focuses on the level of significance and abstraction of the content, the teacher's understanding of it, and the connections made with other disciplines and with real life.

6. The lesson involved fundamental concepts of the subject.

The emphasis on "fundamental" concepts indicates that there were some significant scientific or mathematical ideas at the heart of the lesson. For example, a lesson on the multiplication algorithm can be anchored in the distributive property. A lesson on energy could focus on the distinction between heat and temperature.

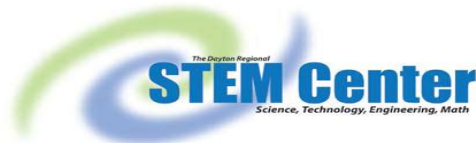
4	The lesson is driven by a fundamental scientific or mathematical content concept.
3	The lesson includes a fundamental scientific or mathematical concept to average depth.
2	The lesson includes a fundamental scientific or mathematical content concept with little or no depth.
1	The lesson is based on a procedural algorithm, not a fundamental scientific or mathematical concept.
0	The lesson has no scientific or mathematical concept at its heart.

7. The lesson promoted strongly coherent conceptual understanding.

The word "coherent" is used to emphasize the strong inter-relatedness of mathematical and/or scientific thinking. Concepts do not stand on their own two feet. They are increasingly more meaningful as they become integrally related to and constitutive of other concepts.

4	The teacher directs the large group discussion/concept building to center on the major math or science concepts of the unit.
3	The teacher solicits a description of the phenomena from the students; but there is little concept building.
2	The students have no opportunity for whole group discussion.
1	The lesson follows a logical progression, but no effort is made to make students aware of the progression or to allow students to organize the structure themselves.
0	The concepts have no interrelatedness; each is isolated from the others.

8. The teacher had a solid grasp of the subject matter content inherent in the lesson.



This indicates that a teacher could sense the potential significance of ideas as they occurred in the lesson, even when articulated vaguely by students. A solid grasp would be indicated by an eagerness to pursue student's thoughts even if seemingly unrelated at the moment. The grade-level at which the lesson was directed should be taken into consideration when evaluating this item.

4	The teacher solicits student input, builds on that input and helps students make sense of the concept.
3	The teacher solicits student input.
2	The teacher does not solicit student input or ideas.
1	The teacher makes a factual error.
0	The teacher makes a factual error in content that when pointed out s/he does not acknowledge.

9. Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.

Conceptual understanding can be facilitated when relationships or patterns are represented in abstract or symbolic ways. Not moving toward abstraction can leave students overwhelmed with trees when a forest might help them locate themselves.

4	The students represent the phenomenon in a symbolic way, and students develop theory through discussion.
3	The students represent the phenomenon in a symbolic way, and teacher develops theory through discussion.
2	The students represent the phenomenon in a symbolic way, or teacher develops theory through discussion.
1	The teacher represents the phenomenon in a symbolic way or teacher explains the theory.
0	No abstract or symbolic representations of the phenomenon are demonstrated and no real theory is developed.

10. Connections with other content disciplines and/or real world phenomena were explored and valued.

Connecting mathematical and scientific content across the disciplines and with real world applications tends to generalize it and make it more coherent. A physics lesson on electricity might connect with the role of electricity in biological systems, or with the wiring systems of a house. A mathematics lesson on proportionality might connect with the nature of light, and refer to the relationship between the height of an object and the length of its shadow.

4	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is valued with a whole class discussion.
3	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is explored.
2	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is mentioned.
1	The lesson is connected to a familiar context, but no real world example,



	application or connection to another discipline is mentioned.
0	The lesson is not connected to a familiar context.

Procedural Knowledge

This section focuses on the kinds of processes that students are asked to use to manipulate information, arrive at conclusions, and evaluate knowledge claims. It most closely resembles what is often referred to as mathematical thinking or scientific reasoning.

11. Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena.

Multiple forms of representation allow students to use a variety of mental processes to articulate their ideas, analyze information and to critique their ideas. A “variety” implies that at least two different means were used. Variety also occurs within a given means. For example, several different kinds of graphs could be used, not just one kind.

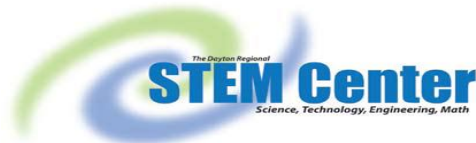
4	The students represent the phenomenon in at least 2 different ways, at least one of which is student choice.
3	The students represent the phenomenon in at least 2 different ways.
2	The students represent the phenomenon.
1	The teacher represents the phenomenon.
0	There is no representation of the phenomenon.

12. Students made predictions, estimations and/or hypotheses and devised a means for testing them.

This item does not distinguish among predictions, hypotheses and estimations. All three terms are used so that the RTOP can be descriptive of both mathematical thinking and scientific reasoning. Another word that might be used in this context is “conjectures”. The idea is that students explicitly state what they think is going to happen before collecting data.

4	The students explicitly make, write down or depict, and explain their prediction, estimation and/or hypothesis. Students devise a means for testing their prediction, estimation and/or hypothesis.
3	The students explicitly make and explain their prediction, estimation and/or hypothesis. Students or teacher devise a means for testing their prediction, estimation and/or hypothesis.
2	The students make a prediction, estimation and/or hypothesis. Students or teacher devise a means for testing the student’s prediction, estimation and/or hypothesis.
1	A prediction, estimation or hypothesis is only done in a large group setting.
0	The students do not make a prediction, estimation or hypothesis.

13. Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.



This item implies that students were not only actively doing things, but that they were also actively thinking about how what they were doing could clarify the next steps in their investigation.

4	The teacher asks the students to reflect upon the procedure. Students critically assess the validity of their procedure.
3	The teacher asks the students to reflect upon the procedure, but no ideas are shared with their group.
2	The students are actively engaged in a thought-provoking activity, but do not assess the validity of the procedure, or how it could be improved.
1	The students are actively engaged, but the activity is not thought-provoking and students do not assess their procedures.
0	The students are passively engaged in the lesson.

14. Students were reflective about their learning.

Active reflection is a meta-cognitive activity that facilitates learning. It is sometimes referred to as “thinking about thinking.” Teachers can facilitate reflection by providing time and suggesting strategies for students to evaluate their thoughts throughout a lesson. A review conducted by the teacher may not be reflective if it does not induce students to re-examine or re-assess their thinking.

4	The students discuss questions such as “How do we know this?” “How can we be sure?” “What does this tell us about what we know?” within their small and large group.
3	The students discuss questions such as “How do we know this?” “How can we be sure?” “What does this tell us about what we know?” only within their small group or large group.
2	There is evidence that some students are thinking about their thinking
1	The teacher asks a question to prompt students to consider how they think about their learning, but no discussion occurs.
0	There is no evidence of student reflection.

15. Intellectual rigor, constructive criticism, and the challenging of ideas were valued.

At the heart of mathematical and scientific endeavors is rigorous debate. In a lesson, this would be achieved by allowing a variety of ideas to be presented, but insisting that challenge and negotiation also occur. Achieving intellectual rigor by following a narrow, often prescribed path of reasoning, to the exclusion of alternatives, would result in a low score on this item. Accepting a variety of proposals without accompanying evidence and argument would also result in a low score.

4	There is critical discussion of the ideas within the small groups and cross-group or whole group.
3	There is critical discussion of the ideas within the small groups or whole group.
2	The students articulate more than one idea.
1	The students articulate one idea, but no competing ideas are offered.
0	The students articulate no ideas related to the activity.



Section 5: CLASSROOM CULTURE (Communicative and Student/Teacher Relationships)

This section addresses a separate aspect of a lesson, and completing these items should be done independently of any judgments on preceding sections. Specifically the design of the lesson or the quality of the content should not influence ratings in this section. Classroom culture has been conceptualized in the RTOP as consisting of: (1) Communicative Interactions, and (2) Student/Teacher Relationships. These are not mutually exclusive categories because all communicative interactions presuppose some kind of relationship among communicants.

Communicative Interactions

Communicative interactions in a classroom are an important window into the culture of that classroom. Lessons where teachers characteristically speak and students listen are not reformed. It is important that students be heard, and often, and that they communicate with one another, as well as with the teacher. The nature of the communication captures the dynamics of knowledge construction in that community. Recall that communication and community have the same root.

16. Students were involved in the communication of their ideas to others using a variety of means and media.

The intent of this item is to reflect the communicative richness of a lesson that encouraged students to contribute to the discourse and to do so in more than a single mode (making presentations, brainstorming, critiquing, listening, making videos, group work, etc.). Notice the difference between this item and item 11. Item 11 refers to representations. This item refers to active communication.

4	The students share their ideas with their classmates using more than one mode of communication.
3	The students share their ideas with their classmates in a small group discussion.
2	The students share their ideas with their classmates in a large group discussion.
1	The students share procedural information but not ideas.
0	The students do not communicate with each other.

17. The teacher's questions triggered divergent modes of thinking.

This item suggests that teacher questions should help to open up conceptual space rather than confining it within predetermined boundaries. In its simplest form, teacher questioning triggers divergent modes of thinking by framing problems for which there may be more than one correct answer or framing phenomena that can have more than one valid interpretation.

4	The teacher asks open-ended questions and offers multiple explanations or explores connected areas to the large group and to small groups.
3	The teacher asks open-ended questions and offers multiple explanations or

	explores connected areas to the large group or to small groups
2	The teacher asks at least one open-ended or divergent question.
1	The teacher asks at least one open-ended question, but it is clear the teacher is looking for a specific answer.
0	The teacher asks no open-ended questions.

18. There was a high proportion of student talk and a significant amount of it occurred between and among students.

A lesson where a teacher does most of the talking is not reformed. This item reflects the need to increase both the amount of student talk and of talk among students. A “high proportion” means that at any point in time it was as likely that a student would be talking as that the teacher would be. A “significant amount” suggests that critical portions of the lesson were developed through discourse among students.

4	This lesson is mostly student talk with critical portions of the lesson developed through student-to-student discourse.
3	A larger portion of the talk is student-to-student; however critical portions of the lesson are not developed through this discourse.
2	The proportion of student-to-student talk to teacher-to-student talk is about equal.
1	There is minimal student-to-student dialog.
0	There is no talk amongst students. Student-instructor dialog (answering questions) is not scored for this item.

19. Student questions and comments often determined the focus and direction of classroom discourse.

This item implies not only that the flow of the lesson was often influenced or shaped by student contributions, but that once a direction was in place, students were crucial in sustaining and enhancing the momentum.

4	The students discuss in their groups, between groups, with the teacher and with the large group. This discourse is central to the development of the description and development of understanding of the phenomenon.
3	The students discuss in their groups and with the teacher. This discourse is central to the development of the description of the phenomenon.
2	The students discuss in their small groups, but the discourse is not central to the development of the description of the phenomenon.
1	The students discuss with the teacher, however student input only slightly influences the focus or direction of the discourse.
0	The teacher determines the direction of the lesson with no student input.

20. There was a climate of respect for what others had to say.

Respecting what others have to say is more than listening politely. Respect also indicates that what others had to say was actually heard and carefully considered. A reformed lesson would encourage and allow every member of the community to present their ideas and express their opinions without fear of censure or ridicule.



4	All students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. All teacher interactions encourage student exploration and/or discussion.
3	All students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. Teacher interactions usually encourage student exploration and/or discussion.
2	Some students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. Teacher interactions seldom encourage student exploration and/or discussion.
1	There is some student interaction. Teacher interaction does not encourage student exploration and/or discussion.
0	There is little or no student interaction. If the students interact, negative comments may occur.

Student/Teacher Relationships

21. Active participation of students was encouraged and valued.

This implies more than just a classroom full of active students. It also connotes their having a voice in how that activity is to occur. Simply following directions in an active manner does not meet the intent of this item. Active participation implies agenda-setting as well as “minds-on” and “hands-on”.

4	The students describe the phenomenon and play a significant role in constructing and validating the final explanation of the phenomenon.
3	The students describe the phenomenon but do not play an adequate role in constructing and validating the final explanation. (Some building of explanation)
2	The students describe the phenomenon but do not participate in constructing or validating the final explanation of the phenomenon. (No building of explanation)
1	The teacher’s questioning strategy involves student participation, but is not closely tied to concept building.
0	Student participation was not encouraged and valued.

22. Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.

Reformed teaching shifts the balance of responsibility for mathematical or scientific thought from the teacher to the students. A reformed teacher actively encourages this transition. For example, in a mathematics lesson, the teacher might encourage students to find more than one way to solve a problem. This encouragement would be highly rated if the whole lesson was devoted to discussing and critiquing these alternate solution strategies.

4	This is valued within groups and is discussed with the large group.
3	This is valued within groups; it is not discussed with the large group.
2	The teacher accepts multiple strategies, conjectures or ways of interpreting



	evidence but makes no effort to solicit multiple ways.
1	The teacher has only one path to the correct answer that is acceptable.
0	The teacher provides all conjectures, solution strategies and ways of interpreting evidence.

23. In general the teacher was patient with students.

Patience is not the same thing as tolerating unexpected or unwanted student behavior. Rather there is anticipation that, when given a chance to play itself out, unanticipated behavior can lead to rich learning opportunities. A long “wait time” is a necessary but not sufficient condition for rating highly on this item.

4	The teacher provides sufficient wait time and ample opportunity for students to explore on their own terms.
3	The teacher provides sufficient wait time, but does not capitalize on all opportunities to allow students to explore on their own terms.
2	The teacher provides sufficient wait time before accepting student responses.
1	The teacher sometimes provides sufficient wait time before accepting student responses.
0	The teacher provides no wait time.

24. The teacher acted as a resource person, working to support and enhance student investigations.

A reformed teacher is not there to tell students what to do and how to do it. Much of the initiative is to come from students, and because students have different ideas, the teacher’s support is carefully crafted to the idiosyncrasies of student thinking. The metaphor, “guide on the side” is in accord with this item.

4	The teacher uses student investigations or questions to direct the inquiry process.
3	The teacher answers questions instead of directing inquiry.
2	The student investigations are teacher prescribed.
1	The teacher demonstrates the phenomenon followed by large group discussion.
0	The class is lecture based.

25. The metaphor “teacher as listener” was very characteristic of this classroom.

This metaphor describes a teacher who is often found helping students use what they know to construct further understanding. The teacher may indeed talk a lot, but such talk is carefully crafted around understandings reached by actively listening to what students are saying. “Teacher as listener” would be fully in place if “student as listener” was reciprocally engendered.

4	The teacher listens to the students and does not dominate group interactions. The teacher asks questions to help the student construct their own understanding.
3	The teacher listens to the students, the students listens to the teacher



	(reciprocity) but the teacher was too directive. The teacher gives too many answers instead of asking questions to help the student construct their own understanding.
2	Some attempts are made by the teacher to check initial student knowledge, incorporate student ideas into the lesson, and assess final student understanding of the material.
1	At least one attempt is made by the teacher to check initial student knowledge, or incorporate student ideas into the lesson, or to assess final student understanding of the material.
0	There is no attempt by the teacher to check initial student knowledge, or incorporate student ideas into the lesson, or to assess final student understanding of the material.

The RTOP was developed by Arizona Collaborative for Excellence in the Preparation of Teachers. Dayton Regional STEM Center has authored the imbedded rubrics for the 25 established categories. For more information on the RTOP please visit: <http://mathed.asu.edu/instruments/RTOP/index.shtml> or http://physicsed.buffalostate.edu/AZTEC/RTOP/RTOP_full/.