

Characteristics of Highly Effective Science Teaching and Learning

Section One: Learning Climate

Learning Climate: a safe environment supported by the teacher in which high, clear expectations and positive relationships are fostered; active learning is promoted

Teacher Characteristics:

A- Teacher creates learning environments where students are active participants as individuals and as members of collaborative groups. The teacher:

1) creates learning environments where students are active participants as individuals and as members of collaborative groups in creating, questioning, sharing, discussing, reasoning and analyzing the processes involved in solving scientific problems/tasks.

B - Teacher motivates students and nurtures their desire to learn in a safe, healthy and supportive environment which develops compassion and mutual respect.

C- Teacher cultivates cross cultural understandings and the value of diversity. The teacher:

1) Cultivates cross cultural understandings and the value of diversity, including an understanding that women and minorities have historically often been excluded from making contributions to science.

D- Teacher encourages students to accept responsibility for their own learning and accommodates the diverse learning needs of all students.

E- Teacher displays effective and efficient classroom management that includes classroom routines that promote comfort, order and appropriate student behaviors.

F- Teacher provides students equitable access to technology, space, tools and time.

G- Teacher effectively allocates time for students to engage in hands-on experiences, discuss and process content and make meaningful connections.

H- Teacher designs lessons that allow students to participate in empowering activities in which they understand that learning is a process and mistakes are a natural part of learning.

I- Teacher creates an environment where student work is valued, appreciated and used as a learning tool.

Student Characteristics:

A- Student accepts responsibility for his/her own learning. The student:

1) accepts responsibility for his/her own learning (e.g., asking for clarification or additional resources when needed, collecting data responsibly, recording relevant observations).

B- Student actively participates and is authentically engaged. The student:

1) actively participates and is authentically engaged, demonstrating a commitment to achieving a learning goal or target.

C- Student collaborates/teams with other students. The student:

1) collaborates/teams with other students as equal partners, sharing responsibilities and respecting the validity of their scientific data and observations.

D- Student exhibits a sense of accomplishment and confidence. The student:

1) exhibits a sense of accomplishment and confidence, including a willingness to share the results of their scientific investigations and research.

E- Student takes educational risks in class. The student:

1) takes educational risks in class such as being willing to refute the scientific claims of others, and to defend their own scientific assertions.

F- Student practices and engages in safe, responsible and ethical use of technology. The student:

1) practices and engages in safe, responsible and ethical use of information technology, as well as laboratory materials & equipment.



[Download Science Facilitator Overview](#)- click here to download a guide for facilitating Professional Development using the video and print resources below.



[Download Science Learning Climate PD module](#)- click here to download a professional development module on learning climate in science. This module is intended to be used within professional learning communities in your school or district. Be sure to download the Facilitator's Guide (above) as well.



[View the video clip for the Science Learning Climate PD \(DSL/cable\).](#) [\[dialup\]](#) (This video is intended to be a representative ‘snapshot’ of what may commonly be observed in classrooms throughout the Commonwealth—not necessarily as a benchmark of every characteristic for the associated component. Using the Characteristics of High Quality Teaching and Learning, the video clip and the accompanying facilitator’s guide, professional learning communities can engage in conversations around increasing competencies in this component.)

A [KDE Science Newsletter](#) dealing with the topic of Learning Climate in Science is also available for download.

Section Two: Classroom Assessment and Reflection

Classroom Assessment and Reflection: the teacher and student collaboratively gather information and reflect on learning through a systematic process that informs instruction

Teacher Characteristics:

A- Teacher uses multiple methods to systematically gather data about student understanding and ability.

B- Teacher uses student work/data, observations of instruction, assignments and interactions with colleagues to reflect on and improve teaching practice.

C- Teacher revises instructional strategies based upon student achievement data.

D- Teacher uncovers students' prior understanding of the concepts to be addressed and addresses students' misconceptions/incomplete conceptions. The teacher:

1) uncovers students' prior conceptions about the concepts to be addressed and addresses students' misconceptions/incomplete conceptions regarding the natural and physical world.

E- Teacher co-develops scoring guides/rubrics with students and provides adequate modeling to make clear the expectations for quality performance.

F- Teacher guides students to apply rubrics to assess their performance and identify improvement strategies.

G- Teacher provides regular and timely feedback to students and parents that moves learners forward.

H- Teacher allows students to use feedback to improve their work before a grade is assigned.

I- Teacher facilitates students in self- and peer-assessment.

J- Teacher reflects on instruction and makes adjustments as student learning occurs.

Student Characteristics:

A- Student recognizes what proficient work looks like and determines steps necessary for improving his/her work.

B- Student monitors progress toward reaching learning targets.

C- Student develops and/or uses scoring guides periodically to assess his/her own work or that of peers.

D- Student uses teacher and peer feedback to improve his/her work.

E- Student reflects on work and makes adjustments as learning occurs.

A [KDE Science Newsletter](#) dealing with the topic of Classroom Assessment and Reflection is also available for download.

Section Three: Instructional Rigor and Student Engagement

Instructional Rigor and Student Engagement: a teacher supports and encourages a student's commitment to initiate and complete complex, inquiry-based learning requiring creative and critical thinking with attention to problem solving

Teacher Characteristics:

A- Teacher instructs the complex processes, concepts and principles contained in state and national standards using differentiated strategies that make instruction accessible to all students.

B- Teacher scaffolds instruction to help students reason and develop problem-solving strategies. The teacher:

1) models proficiency with the use of appropriate tools, technology and techniques to solve problems in science

C- Teacher orchestrates effective classroom discussions, questioning, and learning tasks that promote higher-order thinking skills. The teacher:

1) Designs science learning tasks (laboratory investigations, data generation & analysis) that promote higher-order thinking skills including skeptically evaluating their own conclusions as well as those of others

D- Teacher provides meaningful learning opportunities for students. The teacher:

1) Provides opportunities to understand how scientific knowledge is generated and justified, and an opportunity to use these understandings

E- Teacher challenges students to think deeply about problems and encourages/models a variety of approaches to a solution. The teacher:

1) encourages/models a variety of approaches (inquiry, observation, controlled experimentation, thought experiments, conceptual modeling) to obtaining data about the natural world

F- Teacher integrates a variety of learning resources with classroom instruction to increase learning options. The teacher:

1) provides experiences for students such as guest presenters, field experiences, and career explorations

G- Teacher structures and facilitates ongoing formal and informal discussions based on a shared understanding of rules of discourse. The teacher:

1) develops with their students an understanding that these rules require scientific discourse to be based on theory and evidence and employ logical reasoning. Builds an understanding that a scientific argument is a non-combative format for supporting or defending a scientific claim and is not an emotional conflict.

H- Teacher integrates the application of inquiry skills into learning experiences.

I- Teacher clarifies and shares with students learning intentions/targets and criteria for success.

Student Characteristics:

A. Student articulates and understands learning intentions/targets and criteria for success.

B. Student reads with understanding a variety of texts. The student:

1) reads informational science texts such as articles in popular press, textbooks, non-fiction books, Internet, etc.

C. Student applies and refines inquiry skills. The student:

- 1) asks and identifies questions and concepts to guide scientific investigations
- 2) designs and conducts scientific investigations
- 3) uses appropriate technology and mathematics to enhance investigations/problem solving (science probes, graphing calculators, spreadsheets)
- 4) formulates and revises explanations and models
- 5) analyzes alternative explanations and models
- 6) collaborates with other scientists/students
- 7) accurately and effectively communicates results and responds appropriately to critical comments
- 8) generates additional testable questions which arise from their investigations, results and discussions

Section Four: Instructional Relevance

Instructional Relevance: a teacher's ability to facilitate learning experiences that are meaningful to students and prepare them for their futures.

Teacher Characteristics:

A- Teacher designs learning opportunities that allow students to participate in empowering activities in which they understand that learning is a process and mistakes are a natural part of the learning. The teacher:

1) emphasizes that science is advanced through investigation, and that 'mistakes' often lead to new and valuable learning.

B- Teacher links concepts and key ideas to students' prior experiences and understandings, uses multiple representations, examples and explanations.

C- Teacher incorporates student experiences, interests and real-life situations in instruction. The teacher:

1) engages students with the real world data, tools, expert practitioners and expert references (vs. popular or fictional pseudoscience) they will encounter in college, on the job and in life.

D- Teacher selects and utilizes a variety of technology that support student learning. The teacher:

1) provides opportunities to utilize scientific tools such as electronic data collection, probeware, graphing calculators, laboratory equipment, online data sources, etc.

E- Teacher effectively incorporates 21st Century Learning Skills that prepare students to meet future challenges.

F- Teacher works with other teachers to make connections between and among disciplines. The teacher:

1) explicitly demonstrates how science is inextricably linked to other subjects.

G- Teacher makes lesson connections to community, society, and current events.

Student Characteristics:

A- Student poses and responds to meaningful questions.

B- Student uses appropriate tools and techniques to gather, analyze, and interpret quantitative and qualitative data.

C- Student develops descriptions, explanation, predictions, and models using evidence. The student:

- 1) evaluates the validity of alternate explanations and predictions.
- 2) thinks critically and logically to identify the relationships between evidence and explanations.
- 3) poses and evaluates models/arguments based on evidence and applies conclusions generated from them.

D- Student works collaboratively to address complex, authentic problems which require innovative approaches to solve. The student:

- 1) exhibits skills, attitudes and values associated with scientific inquiry.

E- Student communicates knowledge and understanding in a variety of real-world forms. The student:

- 1) explores scientific issues underlying national and local decisions and expresses positions (in speech and writing) that are scientifically and technologically informed.

F- Student communicates knowledge and understanding for a variety of purposes. The student:

- 1) communicates to facilitate collaboration, persuade, disseminate information, and for formative & summative assessments.

G- Student evaluates the quality and accuracy of scientific information on the basis of its source and methods used to generate it.

Section Five: Knowledge of Content

Knowledge of Content: a teacher's understanding and application of the current theories, principles, concepts and skills of a discipline.

Teacher Characteristics:

A- Teacher demonstrates an understanding and in-depth knowledge of content and maintains an ability to convey this content to students. The teacher:

- 1) understands the science content that is required by the Program of Studies.
- 2) demonstrates strong pedagogical content knowledge through the design of highly effective learning experiences that allow students to explore and develop science understandings.

B- Teacher maintains on-going knowledge and awareness of current content developments. The teacher:

- 1) emphasizes current best understandings related to scientific phenomena (rather than commonly held, historic misconceptions).

C- Teacher designs and implements standards-based courses/lessons/units using state and national standards.

D- Teacher uses and promotes the understanding of appropriate content vocabulary. The teacher:

1) employs strategies for vocabulary acquisition that emphasize conceptual knowledge rather than simple recall.

E- Teacher provides essential supports for students who are struggling with the content. The teacher:

1) makes available a variety of resources (print, multimedia, etc.), including models (concrete, conceptual, relational, etc.), for students who are struggling with the content/concepts being addressed.

F- Teacher accesses a rich repertoire of instructional practices, strategies, resources and applies them appropriately.

Student Characteristics:

A- Student demonstrates growth in content knowledge. The student:

- 1) develops understanding of fundamental scientific principles and theories.
- 2) knows and can apply the processes of science (e.g., observing, predicting, analyzing, etc.).
- 3) explores and understands foundational models and their use for conceptualizing phenomena, predicting events, interpreting empirical evidence, formulating refinements to models.

B- Student uses and seeks to expand appropriate content vocabulary. The student:

- 1) seeks to understand the concept rather than simply memorizing a definition.

C- Student connects ideas across content areas. The student:

- 1) understands that scientific thinking is not limited to the science classroom, but applies to the world at large.

D- Student uses ideas in realistic problem solving situations. The student:

- 1) uses scientific ways of thinking and working to tackle real-world issues.