

APEX Teacher Characteristics in Teaching Force and Motion.

APEX physics teaching characteristics, methods, and strategies are used as evidence to say whether a teacher has high fidelity in implementing the innovative APEX program he/she experienced. On the other hand if we do not see them, or see few of them, then we are not observing APEX physics teaching.

Rubric	<i>APEX Model Teacher Characteristics</i>
5 12-20 Expert use	Demonstrates excellence in implementing and appropriately using MOST of the APEX characteristics, methods, and strategies experienced on the APEX professional development workshops. The planning and implementation is of a significant depth of use and length of time to be applied during the lessons and not “tokenly used” to cover the physics lesson concept. Characteristics are accurately applied and expressed clearly in an inquiry lesson structure. Includes examples of 8-10 critical characteristics described in the APEX list.
4 8-11 Proficient or Participant	Demonstrates evidence of implementing and appropriately using MANY of the APEX characteristics, methods, and strategies experienced on the APEX professional development workshops. The planning and implementation is occasionally of significant depth of use and length of time to be applied during the lessons and not “tokenly used” to cover the physics lesson concept. The teacher shows some skill in applying characteristics accurately and expressed clearly in an inquiry lesson structure.
3 5-7 Emergent or Mechanical use	Demonstrates evidence of implementing and appropriately using SOME of the APEX characteristics, methods, and strategies experienced on the APEX professional development workshops. The planning and implementation is occasionally of significant depth of use and length of time to be applied during the lessons and not “tokenly used” to cover the physics lesson concept. The teacher shows some skill in applying characteristics accurately and expressed clearly in an inquiry lesson structure. Some signs of inaccuracy; disorganization with implementation.
2 3-4 Novice use	Demonstrates evidence of implementing and appropriately using a FEW of the APEX characteristics, methods, and strategies experienced on the APEX professional development workshops. Has a mostly shallow grasp of the planning and implementation of use or length of time to be effectively applied during the lessons and may be “tokenly used” to cover the physics lesson concept. The teacher shows lack of skill in applying characteristics accurately and/or expressing clearly in an inquiry lesson structure, partial inaccuracy is present, implementation seems disjointed.
1 0-2 Non-use or Trial use	Demonstrates little or no evidence of implementing and appropriately using ANY of the APEX characteristics, methods, and strategies experienced on the APEX professional development workshops. Has a shallow grasp or understanding of the planning and implementation use to be applied during the lessons or may not be used to teach the physics lesson concept. The teacher shows a lack of skill in applying characteristics accurately and/or expressing clearly in an inquiry lesson structure, inaccuracy is present, implementation seems disjointed.

What the APEX physics teacher does in teaching force and motion. Strategies found in Action Research units with higher student achievement are underlined, based on 2014-17 data sources.

1. **Guided inquiry laboratory** activities
2. **Five E learning cycle** is used in planning and teaching physics lessons
3. **Graphical analysis of data- 4 step analysis**. Students have made a graph. If it is not straight, they have re-graphed the data to make it straight. Then they write
 - a) $y = mx + b$
 - b) substitute the actual graph's y and x variable letters, like D and t.
 - c) determine in the actual slope, with units for m and the actual y intercept with unit for b
 - d) develop and write the physics equation with letters representing what the slope and y intercept mean. Example $d(\text{final}) = vt + d(\text{initial})$
4. **Guided inquiry laboratory activities** as a majority of the physics lesson(s) – student engagement, use of evidence in answering questions and giving explanations– See *Inquiry Teacher Actions and Student Responses* in Columns #2 and #3 in handout attached.
5. **Identification** and addressing student **alternative conceptions**
6. **Use of Diagnoser (prior knowledge) or similar inquiry activities in planning physics lessons**
7. **Use of Diagnoser (prior knowledge) investigations by students in teaching and getting feedback during physics lessons**
8. **Use of questioning** that calls for **higher student reasoning and teaching strategies** providing **higher level learning tasks** from students during the teaching of physics lessons
9. **Public presentations and Argumentation** --e.g. whiteboards or other student presentation styles. The student explains results or reasoning on a problem or event and/or teacher collects feedback from students in groups or in individual presentations.
10. **Ranking tasks and Tippers** -- are used and discussed during the physics lesson. Several situations or graphs are pictured. Students have to rank order them according to some characteristic
11. **Four Rules of Scientific Reasoning** are discussed during the physics lesson, Specify so the rule is noted.

Rule 1: Nature is pleased with simplicity - a version of [Ockham's Razor](#).

Rule 2: a logical consequence from [Rule I](#). The same data leads to the same conclusion

Rule 3: Physical properties are universal

Rule 4: that the argument of induction may not be evaded by hypotheses." This is like the 4-step analysis we use. We start with specific data, and then by induction find a general relationship.
12. **GUESS** is used to work problems during physics lessons. Write the Givens, Unknown, Equation to use, Substitute into the equation, Solve for the answer.
13. **Planning with APEX/PTRA and other professional development materials from APEX workshops are used** in designing the majority of physics lessons in addition to textbook or AMSTI/ASIM materials.
14. **Use of technology by students to facilitate learning** – Some of Pasco, Logger Pro, PhETs, Video analysis, sensor probes **are used** in teaching physics lessons
15. **Teaching with APEX/PTRA and other professional development materials from APEX workshops are used** in teaching the majority of physics lessons in addition to textbook or AMSTI/ASIM materials.
16. **Mathematical modeling** activities are used to explore and explain physics concepts
17. **Free body diagrams** are used in to explain and understand resultant forces and in solving problems
18. **Student talk and control of learning during the lesson** is equal to or greater than teacher talk and control of the lesson in majority of the lessons (classroom and/or lab direction) - Student orientation vs Teacher orientation.
19. **Predictions and “on the spot” calculations** are used by students to estimate results and get feedback on problem and lab procedure or direction to follow.
20. **Use of formative assessment strategy and feedback** is continuously used during the physics lesson

21. Inquiry Teacher Actions and Student's Responses: Essential Features of Classroom Inquiry and Their Variations

Essential Features of Inquiry	1 Full Inquiry Teaching (Can Use Learning Cycle)	2 Coupled Inquiry (Can Use Learning Cycle)	3 Guided Inquiry	4 Directed Inquiry	5 Verification	6 Expository
1. Learner engages in scientifically oriented questions	Learner poses a question to investigate	Learner selects among questions, poses new questions	Learner sharpens or clarifies question provided by teacher, materials, or other source	Learner engages in question provided by teacher, materials, or other source	Learner engages in question that <u>replicates</u> one provided by teacher, materials, or other source	Learner engages in no question to investigate
2. Learner gives priority to evidence in responding to questions	Learner determines what constitutes evidence and collects it	Learner directed to collect certain data	Learner given data and asked to analyze	Learner given data and told how to analyze	Learner given data and told how to analyze that <u>replicates</u> one provided	Learner given no data just conclusions
3. Learner formulates explanations from evidence	Learner formulates explanation after summarizing evidence	Learner guided in process of formulating explanations from evidence	Learner given possible ways to use evidence to formulate explanation	Learner provided with evidence	Learner provided with evidence that replicates conclusions already given	Learner provided with no evidence, only conclusions
4. Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner directed toward areas and sources of scientific knowledge	Learner given possible connections	Learner provided with connections	Learner provided with connections that <u>replicates</u> one provided	Teacher reports connections
5. Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanations	Learner coached in development of communication	Learner provided broad guidelines to sharpen communication	Learner given steps and procedures for communication	Learner reports how close to the textbook the conclusions were	Learner reports no conclusions

More ←----- Amount of Learner Self-Direction -----> Less

Less ←-----Amount of Direction from Teacher or Material -----> More

Dennis W. Sunal (2013), Modified from National Research Council. (2000). *Inquiry and the National Science Education Standards*. National Academy Press, p. 29 and published in Sunal, D. Sunal, C., Sundberg, C., and Wright, E. (2008). The importance of laboratory work and technology in science teaching. In Sunal, D. & Wright, E. (Eds.), *The impact of the laboratory and technology on learning and teaching science K-16*. Greenwich, CT: Information Age Publishing, 1-28.