

TABLE 1**4E instructional model (modified from Bybee et al., 2006).**

4E model	Definition	Teacher and student roles
Engagement	Create an interest by raising questions for inquiry	Teacher creates curiosity, raises questions to probe for preconceptions, and acts as a facilitator
		Students are intellectually engaged and show academic interest and prior knowledge
Exploration	Open investigations to experience the phenomenon, collect evidence through observation and measurement, test ideas, and try to answer questions	Teacher asks probing questions to direct investigation and acts as a facilitator
		Students engage in group activities through exploration
Explanation	Construct multi-model explanations and justify claims in terms of the evidence gathered; compare explanations generated by different students/groups	Teacher explains the basic concepts and engages students into whole-class discussion
		Students listen, answer the questions, and make explanations
Evaluation	Provide evidence for changes to students' understanding, beliefs, and skills	Teachers assess students' understanding through pre-prepared questions as summative assessment
		Students work on the summative assessment materials

TABLE 2**Explanation phase: Questions and expected responses.**

		Metal ball	Metal leaves	Metal leaves
Blue ball	brings up	Blue	Blue	Close
	touches	Red	Red	Open
Red ball	brings up	Blue	Blue	Close
	touches	Red	Red	Open
Which charges begin to move when the negative ball is brought near the electroscope?		<i>Negative charges move to the bottom of the electroscope.</i>		
Which charges begin to move when the positive ball is brought near the electroscope?		<i>Negative charges move to the metal ball; leaves are charged positively. The leaves repel each other.</i>		

TABLE 3**Connecting the lesson to the Next Generation Science Standards (NGSS Lead States, 2013).**

MS-PS2: Motion and Stability: Forces and Interactions		
MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.		
Disciplinary Core Ideas		
PS2. B. Types of Interactions		
Forces that act at a distance (electric) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object or a ball etc.).		
Science practices	Classroom connections	Nature of science
Developing and using models	Students create or use models of electrical interactions.	Scientific knowledge is derived based on observation and experiments.
Planning and carrying out investigations	Students conduct an observation through a simulation to collect data serving as a basis for evidence.	
Constructing explanations	Students construct explanations based on their observations.	