Appendix A.—Rubric for 5E Instructional Model

5E Step	Novice (0)	Apprentice (1)	Journeyperson (2)	Expert (3)	Level of student knowledge (Score)
Engage	Student does not identify any prior knowledge or connections to previous learning experiences	Student identifies irrelevant or inaccurate prior knowledge or connections to previous learning experiences	Student identifies one example of relevant and accurate prior knowledge or connection to previous learning experience	Student identifies two or more examples of relevant and accurate prior knowledge or connections to previous learning experiences	
Explore	Student does not participate in brainstorming discussion	Student participates in brainstorming discussion (asks questions, for example) but does not contribute possible hypotheses, solutions, or tests	Student contributes at least one possible hypothesis, solution, or test to brainstorming	Student contributes at least one possible hypothesis, solution, or test to brainstorming and an alternative or improvement to another student's idea	
Explain	Student does not provide explanation of observations	Student provides an explanation of observations that is inaccurate, incomplete, or lacks evidence	Student provides an accurate, complete explanation of observations based on evidence	Student provides an accurate, complete explanation of observations based on evidence and supplements their reasoning with either evidence or evidence-based explanations from others	
Elaborate	Student does not draw reasonable conclusions based on evidence	Student draws reasonable conclusions but does not utilize scientific terminology or evidence	Student draws reasonable conclusions utilizing scientific terminology and evidence	Student draws reasonable conclusions utilizing scientific terminology as well as evidence and can make reasonable predictions based on those conclusions	
Evaluate	Student does not demonstrate understanding of concept or can only repeat provided definitions	Student demonstrates an understanding of concept by providing definitions or explanations in their own words, drawings, models, etc.	Student demonstrates an understanding of concept by applying it to new questions or by analyzing new evidence	Student demonstrates an understanding of concept by explaining how evidence caused their knowledge to progress over time or by proposing new ways to use their new knowledge (such as followup experiments)	
				Total	

Appendix B.—Glossary of Key Terms

Absorption. To soak something in, like water into a sponge; in the context of this guide, absorption occurs when photons from light hit atoms or molecules, which converts the light energy into vibrations

Abstraction. In computer science, a representation of data that focuses on the important details

Algorithm. Step-by-step process

Antenna. A structure that receives or sends electromagnetic waves such as radio waves; found on many space communications systems, from ground stations to satellites

Artemis. NASA's mission to land the first woman and next man on the Moon by 2024

Binary notation. Number system with the base of 2, which are the kinds of numbers most commonly used by computers. Digits can be 0 or 1. The binary notation of nineteen is 10011.

Bit. A single binary digit

Byte. A contiguous sequence of eight bits

Cipher. A coded message

Communications. The exchange of information from one place or person to another

Data. A collection of information, such as facts, numbers, measurements, photos, or observations

Decimal notation. Number system with the base of 10, which are the kinds of numbers most commonly used by people. Digits can be 0 through 9. The decimal notation of nineteen is 19.

Degraded. Reduced in quality; in communications, analog or digital signals can become degraded

Delay. A period of time by which an analog or digital signal is late or postponed

Delay/Disruption Tolerant Networking (DTN). A computer networking model and a system of rules for transmitting information (referred to as a protocol suite) that extends internet capabilities into the challenging communication environments in space, where the conventional internet does not work well

Deliver. Successfully send an analog or digital signal to a destination

Graph. A visual representation of a network of nodes in computer science

Ground station. A surface-based facility designed to provide real-time communication with satellites by sending and receiving radio signals

Hexadecimal notation. Number system with the base of 16 that uses numerals 0 through 9 and represents digits greater than 9, with letters A through F representing 10 through 15. Hexadecimal notation is commonly used by advanced computers. The hexadecimal notation of nineteen is 13.

Minimum spanning tree. A graph where every node is connected to the graph in the most efficient way

Navigation. A determination of current position in planning and following a route

Nybble. Four bits grouped together

Packetizing. Breaking up data into smaller segments (packets) for transmission across a network

Protocol. A procedure for carrying out the exchange or transmission or data

Receiver. Person or device that receives waves, electrical signals, or the like from the transmitter

Deep Space Communications

Satellite. A spacecraft that orbits the Earth, the Moon, or another celestial body; satellites use radio signals to communicate with ground stations on Earth and with rovers on the Moon and Mars

SCaN. NASA's Space Communications and Navigation (SCaN) program; SCaN has antennas around the world and satellites in space to help guide spacecraft and exchange important information with all NASA spaceflight missions

Signal. A radio wave that has been modulated to carry information; in the context of this guide, a signal is communication with a spacecraft over a distance

Transmission. The sending and receiving of information by radio waves in space

Transmitter. The person or device sending a message or data