TABLE 1

Connections between student actions and components of the *NGSS* in Part I of the project.

DESIGN THINKING PHASE	STUDENT ACTIONS	CONNECTIONS TO NGSS COMPONENTS
Part I: Build empathy	Performed research related to chickens, observed chickens in the barnyard, engaged in small-group discussions to share observations with classmates.	PE: 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
	Examined observation data to identify opportunities to improve nesting conditions.	SEP: Analyzing and interpreting data. Use data to evaluate and refine design solutions.
	Observed chickens with the goal of responding to observed behaviors in order to increase chicken egg production.	DCI: LS1.A. Structure and function. Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.
	Made detailed observations about the system under study (chickens in the henhouse).	CCC: Systems and system models. A system can be described in terms of components and their interactions.

Note: PE = performance expectation, SEP = science and engineering practice, DCI = disciplinary core idea, CCC = crosscutting concept

TABLE 2

Connections between student actions and components of the *NGSS* in Part II of the project.

DESIGN THINKING PHASE	STUDENT ACTIONS	CONNECTIONS TO <i>NGSS</i> COMPONENTS
Part II: Define the problem and propose solutions	Collaborated in small groups to identify possible reasons why chickens would not routinely lay eggs in the henhouse. Brainstormed and evaluated possible solutions to the egg-laying problem.	PE: 3-5-ETS1-1. Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time, or cost. PE: 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
	Created sketches and descriptions of their possible solutions to the egg-laying problem.	SEP: Constructing explanations and designing solutions. Use evidence to construct or support an explanation or design a solution to a problem.
	Gave feedback to their classmates regarding the feasibility of possible solutions to the egg-laying problem.	DCI: ETS1.A and ETS1.B Defining and delimiting engineering problems and developing possible solutions. At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.
	Selected several promising possible solutions to the egg-laying problem— including nesting boxes—to prototype.	CCC: Structure and function. Substructures have shapes and parts which serve functions.

Note: PE = performance expectation, SEP = science and engineering practice, DCI = disciplinary core idea, CCC = crosscutting concept

TABLE 3

DESIGN THINKING PHASE	STUDENT ACTIONS	CONNECTIONS TO NGSS COMPONENTS
Part III: Prototype and test	Created several different prototypes using low-resolution materials and tested them by placing them in the henhouse so that the chickens could interact with them. Troubleshot design features to improve early nesting box designs when prototypes were considered failures.	PE: 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
	Formally proposed a solution to the egg-laying problem to the school's administration using a multimedia presentation.	SEP: Engaging in argument from evidence and communicating information. Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.
	Performed several iterations of testing, observing, and refining, eventually arriving at a nesting box design in which chickens began laying eggs. Created high-resolution nesting box prototypes.	DCI: ETS1.C Optimizing the design solution. Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and constraints.
	Installed new nesting boxes in the henhouse resulting in a sharp increase in chicken egg production.	CCC: Cause and effect. Cause and effect relationships are routinely identified, tested, and used to explain change.

Connections between student actions and components of the NGSS in Part III of the project.

CCC = crosscutting concept