Supplemental Material

Hester *et al.*

SUPPLEMENTAL MATERIALS

Table S1. Structure matrix coefficients for exploratory factor analysis of Project Ownership Survey responses.

Question	Factor 1	Factor 2	Factor 3	Factor 4
Q1	**0.886**	0.508	0.597	0.527
Q2	**0.830**	0.520	0.651	0.531
Q3	**0.746**	0.520	0.567	0.569
Q4	0.615	0.492	**0.853**	0.546
Q5	**0.642**	0.576	0.592	0.523
Q6	0.601	0.467	**0.884**	0.461
Q7	0.575	0.493	**0.911**	0.533
Q8	0.262	0.230	0.235	**0.327**
Q9	0.414	0.438	0.481	**0.815**
Q10	0.380	0.387	0.314	**0.685**
Q11	0.548	0.531	0.649	**0.724**
Q12	0.429	0.373	0.383	**0.479**
Q13	0.423	**0.801**	0.394	0.446
Q14	0.465	**0.823**	0.424	0.468
Q15	0.270	**0.284**	0.181	0.185
Q16	0.435	**0.553**	0.417	0.399

We identified four categories using an exploratory factor analysis using maximum-likelihood extraction with oblimim with Kaiser normalization rotation. Pattern and structure matrix coefficients were consistent with one another in assigning questions to categories. Question numbers are from Table 5 of Hanauer and Dolan (2014).

Table S2. Identified Project Ownership Categories

Factor Number	Category	Questions
1	Personal Investment	1, 2, 3, 5
2	Real-World Contributions	13, 14, 15, 16
3	Positive Emotions	4, 6, 7
4	Self-Efficacy and Unexpected Experiences	8, 9, 10, 11, 12

Question numbers are from Table 5 of Hanauer and Dolan (2014).

Model Diversity Coding Scheme

Transfer (TRAN)	Model explanation includes the idea that species A transfers something (signal, enzyme, gene, other) to E to give E the ability to survive in the CA media.
Nutrients (NUT)	Model explanation includes the idea that species E is able to directly provide nutrients/energy to species A. This could be E lives of A waste/byproducts or A secretes/provides something that E needs for nutrition.
Acid Attack (AA)	Model explanation includes the idea that species E is unable to survive alone in CA due to a harsh/acidic environment. May/may not include a mechanism for how species A helps E in this environment.
CA metabolism (MET)	Model explanation includes the idea that species A makes an enzyme to break down CA.
Cell Wall (CW)	Model explanation focuses on the lack of E growth in CA. It includes the idea that differences in the cell wall between the two species accounts for differences in growth. (Do not code with any of the above.)
E Deficient (ED)	Model explanation focuses on the lack of E growth in CA. It includes the idea that species E is missing something that would allow it to use the nutrients in CA or is somehow inhibited from using those nutrients. (Do not code with any of the above.)
Other (OTHER)	Model suggests an explanation that does not clearly fit into one of the above categories. (Do not code with any of the above.)
No mechanism (NONE)	The model illustrates the phenomenon, but does not suggest a phenomenon to explain it. (Do not code with any of the above.)

Each model drawing was coding with the above categories. More than one category could be applied to a single model drawing unless otherwise noted.

<u>Coding scheme for written survey</u>

1. What is an experiment? (Exclusive codes)

1. Student does not discuss the idea that an experiment is meant to test or answer something.
2. Student mentions that an experiment tests something but does not specify what.
3. Student states that an experiment is meant to answer a question or figure out how something is working and does not discuss its role in testing a prediction or hypothesis.
4. Student states that an experiment tests a hypothesis or prediction.

2. Please describe an example of an experiment. (Non-exclusive codes)

a. Student describes an experimental method outside of the context of a question, hypothesis or prediction.
b. Student describes a question or prediction about a relationship between variables (may call it a hypothesis) or how an outcome may vary between different conditions.
c. Student describes a mechanistic hypothesis being tested.
d. Student describes an experimental condition.
e. Student describes a control condition.
f. Student describes a conclusion or interpretation of the experiment/what they learned.
g. Student describes a mechanistic (how/why) question addressed by an experiment

What is a scientific theory? (Exclusive codes)

0. EC: Does not mention proof.
1. EC: A theory can't be proven.
2. EC: A theory is an unsupported guess.
3. EC: A theory has been proven.
4. EC: A theory is a hypothesis with evidence (doesn't indicate that this is significant evidence).
5. EC: A theory hasn't been disproven (has withstood many tests) or is very well supported.

Have you ever felt like a scientist? (Yes/No) Please explain your answer.

A. Does the lab make them feel like a scientist? (Exclusive codes)

1. They say "no."
2. They say "yes" and do not specifically mention the MCB181 lab.
3. They say "yes" and specifically mention the MCB181 lab.

B. Criteria for feeling like a scientist. (Non-exclusive codes)

a. Content/Understanding: learning, understanding or verifying scientific facts
b. Procedural: wearing a lab coat, mixing chemicals, etc.
c. Novelty: trying new things, innovating (but not seeking to explain)

d. "Critical thinking": student describes/names challenging cognitive tasks not otherwise listed ("critical thinking," "problem solving," etc.)
e. Asking questions
f. Explanation building: seeking to explain phenomena
g. Hypothesis-testing
h. Autonomy: Having control, designing own experiments, etc.
i. Designing experiments and drawing conclusions

Calculating the Nature of Science Score

Total of 9 possible points, 3 for each of the following categories

1. **Purpose of experiment:**

   0 = No code or code 1

   1 = code 2

   2 = code 3

   3 = code 4

2. **Description of experiment:**

   0 = Non-experiment (ex. I predict that if I drop my cell phone it will break, then I look to see if it broke) or code a
   1 = Control of Variables proposal – code b only
   2 = Control of Variables proposal with elaboration (conditions, controls, and/or results) – codes d, e and/or f
   3 = Mechanistic Hypothesis – code c or g

3. **Definition of a Theory:**

   0 = not coded or code 0

   1 = coded as 1, 2, or 3

   2 = coded as 4

   3 = coded as 5