

Supplemental Material

CBE—Life Sciences Education

Kenyon *et al.*

Supplemental Materials

Kenyon et al., "Testing CREATE at Community Colleges: An Examination of Faculty Perspectives and Diverse Student Gains"

Table of Contents

OE Weiss Observation Protocol (Appendix A)	2 -13
OE Student Survey (Appendix B)	14 - 15
OE Interview Protocol for Faculty Implementers (Appendix C)	16
Figure S1. "Integration" Subset of Four SALG Statements	17
Table S1. OE Evaluation of CREATE Implementation	18
Table S2. EDAT Outcomes on Individual CC Campuses	19
Table S3. CTT Outcomes on Individual CC Campuses	20
Table S4. Student Responses to OE Survey	21

Appendix A

OBSERVATION PROTOCOL FOR THE C.R.E.A.T.E. MODEL¹

Protocol Purpose: To gather accurate information about how the program functions in a specific situation with one Implementer during an actual session.

Background Information

Observer _____ Date of Observation _____

Location: _____ Travel time: _____

Title of Course: _____

Name of Implementer: _____

Total Number of Attendees: _____ Female: _____ Male: _____ Est. White: _____

Duration of Observation. Begin time: _____ End time: _____

Part I: Context Background & Activities

This section provides a brief overview of the session under observation.

I. Session Context

In a few sentences, describe the session you observed. Was it a partial or complete session?

¹ Protocol is adapted from the Local Systemic Change Observation Protocol developed by Iris Weiss (1997) for the National Science Foundation.

II. Session Focus

1. What was the major intended purpose of this session based on information provided by the Implementer?

2. What was the major observed purpose of this session?

III. Classroom Environment

Make a drawing of the classroom setup, indicate major furniture, whiteboards, equipment, doorways, windows, and locations of students, implementer, observer, and identified others that may be present.

IV. Instructional Activities (*Check all activities observed*)

A. Indicate the major instructional resource(s) used in this session and describe.

- ___ print materials
- ___ hands-on materials
- ___ laboratory materials
- ___ technology/audio-visual resources
- ___ other instructional resources (please specify)

B. Indicate the major way(s) in which student activities were structured; estimate the total amount of time spent on each.

Time/Brief Description

Begin /End	Brief Description	Est. Total Time
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←use prior verso ___ whole group

___ small groups-----use verso-----→

___ pairs

___ individuals

C. Indicate the major activities observed in this session; describe the focus of each and indicate whether whole group (W), small group (S), pairs (P), individuals (I).

___ Implementer lecture:

___ Participant presentation:

___ All “hands-on” activities (including labs):

___ All “minds-on” activities:

____ Informal discussions:

____ Reading activities:

____ Writing activities:

____ Assessment activities:

____ Other activities:

D. Comments

Please provide additional information you consider necessary to capture the atmosphere, content, and context of this session. Include small drawing of t-s, s-s, s-t interactions.

Part II: Ratings

Using the information collected in Part I plus your observations to rate each of the key indicators from 1 (not at all) to 5 (to a great extent) by circling the correct response. Use 6 (don't know) when not enough evidence exists to make a judgment and 7 (N/A) when you consider the indicator inappropriate for the purpose and context of the session. Similarly, there may be entire rating categories not applicable to a particular session. Make notes on the right of special circumstances, conditions, and limitations.

Use your "Ratings of Key Indicators" from A to inform your "Synthesis Ratings" from B and indicate in C, "Supporting Evidence for Synthesis Ratings," what factors were *most influential* in determining your synthesis ratings.

I. Design of Session

This section examines the implementer's session design based on the concepts of C.R.E.A.T.E. as learned in the summer workshop and the PI's subsequent support.

A. Ratings of Key Indicators

	Not at all				To a great extent		Don't know	N/A	Notes
1. The opening of this session was designed to capture the attention of students	1	2	3	4	5	6	7		
2. The opening of this session was designed to refer back to the content of the previous session	1	2	3	4	5	6	7		
3. The session design demonstrated reflective planning & organization	1	2	3	4	5	6	7		
4. The design of instructional strategies & activities used in this session reflected attention to participant experiences, prior learning, & preparedness	1	2	3	4	5	6	7		
5. The session design appropriately placed attention on concepts of C.R.E.A.T.E.1 (note which)		2	3	4	5	6	7		
6. The session design considered student attitudes and/or beliefs	1	2	3	4	5	6	7		
7. The session design effectively built student understandings of the C.R.E.A.T.E. process (note which)	1	2	3	4	5	6	7		
8. The session design effectively									

built on student understandings of the science content (note that content)	1	2	3	4	5	6	7
9. The session design encouraged a collaborative approach to learning	1	2	3	4	5	6	7
10. The design of the session provided opportunities for “minds on” thinking about science content through primary literature	1	2	3	4	5	6	7
11. The session design provided opportunities for “hands on” applications that provided learning of science concepts through the nature of science	1	2	3	4	5	6	7
12. The session design allowed adequate time & structure for reflection and discussion	1	2	3	4	5	6	7
13. The session design allowed adequate time & structure for participants to gain understanding of the primary literature	1	2	3	4	5	6	7
14. The session design incorporated tasks, roles, & interactions consistent with a spirit of inquiry	1	2	3	4	5	6	7
15. The session design effectively built on student understanding of the nature of science	1	2	3	4	5	6	7
16. The session design was appropriate for changing the epistemological beliefs of the students	1	2	3	4	5	6	7
17. The session design was appropriate for accomplishing the implementer’s purpose/goals	1	2	3	4	5	6	7
18. The session design was appropriate for teaching students science using the C.R.E.A.T.E. model	1	2	3	4	5	6	7
19. Other (describe):	1	2	3	4	5		

B. Synthesis Rating

	1	2	3	4	5
Design of the session was not at all reflective of best practices for C.R.E.A.T.E.					Design of the session was extremely reflective of best practices for C.R.E.A.T.E.

C. Supporting Evidence for Synthesis Rating

II. Instruction of Session

This section examines the implementer’s session instruction based on the concepts of C.R.E.A.T.E. as learned in the summer workshop and the PI’s subsequent support.

A. Ratings of Key Indicators

	Not at all					To a great extent	Don’t know	N/A	Notes
1. Initiation of session effectively referred back to key concepts from prior session & tied them to current session	1	2	3	4	5	6	7		
2. The implementer effectively incorporated instructional strategies appropriate for the purposes of the C.R.E.A.T.E. session & the needs of the learners	1	2	3	4	5	6	7		
3. All students were reached during this session	1	2	3	4	5	6	7		
4. Active participation of all students played a major role in the learning process	1	2	3	4	5	6	7		
5. The implementer effectively used questioning strategies likely to enhance the development of conceptual understanding through an emphasis on higher order questions (analysis, synthesis, evaluation)	1	2	3	4	5	6	7		
6. The implementer effectively used questioning strategies likely to enhance the									

development of conceptual understanding through identification of misconceptions	1	2	3	4	5	6	7
7. The pace of the session was appropriate for the purposes of C.R.E.A.T.E. and the needs of the learners	1	2	3	4	5	6	7
8. Routines and transitions were orderly and efficient and resulted in minimal time off task	1	2	3	4	5	6	7
9. Ample opportunities for critical thinking were provided to reflect on newly integrated knowledge & applications to novel situations	1	2	3	4	5	6	7
10. The implementer's background, experience, and/or expertise enhanced the quality of the session	1	2	3	4	5	6	7
11. The implementer's management style/strategies enhanced the quality of the session (note style)	1	2	3	4	5	6	7
12. Active participation of all students was encouraged and valued	1	2	3	4	5	6	7
13. There was a climate of respect for student experiences & contributions	1	2	3	4	5	6	7
14. The implementer's language & behavior demonstrated sensitivity to variations in student gender, age, ethnicity &/or culture (circle which)	1	2	3	4	5	6	7
15. Interactions reflected collaborative working relationships among students	1	2	3	4	5	6	7
16. Interactions reflected collaborative working relationships between implementer and students	1	2	3	4	5	6	7
17. The implementer monitored students formally &/or informally and consistently focused on student understanding of content and skills	1	2	3	4	5	6	7
18. The implementer adjusted lesson through varied strategies & activities to provide a deeper understanding of content & skills	1	2	3	4	5	6	7
19. The implementer showed awareness of various student learning styles during instruction	1	2	3	4	5	6	7
20. The implementer demonstrated the							

ability to teach the various tenets of C.R.E.A.T.E. (note which)	1	2	3	4	5	6	7
21. Constructivism (students constructing new understandings on existing knowledge) was present throughout the session	1	2	3	4	5	6	7
22. Teacher role was that of facilitator rather than lecturer	1	2	3	4	5	6	7
23. The implementer developed the science knowledge of students	1	2	3	4	5	6	7
24. The implementer developed student understanding of the nature of science	1	2	3	4	5	6	7
25. The implementer adeptly used C.R.E.A.T.E. methods to teach students through the primary literature	1	2	3	4	5	6	7
26. The implementer developed student abilities to make connections & applications to the real world	1	2	3	4	5	6	7
27. The degree of closure or resolution of conceptual understanding was appropriate for the purposes of the session & the needs of learners	1	2	3	4	5	6	7
28. Other (describe):	1	2	3	4	5		

B. Synthesis Rating

				1		2		3
4		5						
Instruction of the session not at all reflective of best practices for C.R.E.A.T.E.						Instruction of the session extremely reflective of best practices for C.R.E.A.T.E.		

C. Supporting Evidence for Synthesis Rating

III. The Nature of Science in Session

This section examines the presence of the nature of science (NOS) observed during the instructional session, as based on the use of primary literature from the summer workshop and the PI's subsequent support. Be sure to describe both direct and indirect references to the nature of science.

A. Ratings of Key Indicators

	Not at all					To a great extent	Don't know	N/A	Notes
1. The nature of science was appropriately presented within the C.R.E.A.T.E. process	1	2	3	4	5	6	7		
2. The nature of science was appropriately presented within the science content	1	2	3	4	5	6	7		
3. The nature of science was portrayed as presuming that things & events in the universe occur in consistent patterns that are comprehensible through careful, systematic study	1	2	3	4	5	6	7		
4. The NOS was explicitly mentioned in the lesson to promote a deeper understanding of science and the processes of inquiry	1	2	3	4	5	6	7		
5. Students overtly demonstrated understanding of the nature of science inquiry	1	2	3	4	5	6	7		
6. Students indirectly demonstrated understanding of the nature of science inquiry	1	2	3	4	5	6	7		
7. NOS processes were used in the lesson to promote a deeper understanding of both science content and inquiry	1	2	3	4	5	6	7		
8. The NOS was treated as an integral part of the C.R.E.A.T.E. process	1	2	3	4	5	6	7		
9. The inquiry approach to learning was present throughout the session	1	2	3	4	5	6	7		
10. Students displayed abilities of inquiry (investigating, analyzing, explaining, evaluating, etc.)	1	2	3	4	5	6	7		
11. Aspects of the C.R.E.A.T.E. Method were appropriately presented/explored within the session	1	2	3	4	5	6	7		

12. Check those C.R.E.A.T.E. elements that were present during session:

using primary literature concept mapping student explanations designing next exp. annotating
 cartooning contacting authors proposal reviewing small group discussions students presenting
 grant panels small group learning analyzing articles in parts transforming data translating
 sentences other (describe):

13. Other (describe):

1	2	3	4	5
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B. Synthesis Ratings

	1	2	3	4	5
NOS was not at all present during session					NOS was extremely present during session

C. Supporting Evidence for Synthesis Ratings

IV. Science Content in Session

This section examines the presence of science content during the instructional session, as based in the use of primary literature, and learned during the summer workshop and the PI's post workshop support. Be sure to describe the science content in the Synthesis Ratings section (B).

A. Ratings of Key Indicators

		Not at all					To a great extent	Don't know	N/A	Notes
1. Science content was appropriate for the purpose of the C.R.E.A.T.E. session and the background of the students	1	2	3	4	5	6	7			
2. The science content was appropriately presented/explored within the C.R.E.A.T.E. process	1	2	3	4	5	6	7			

3. Science content was portrayed as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, &/or proofs	1	2	3	4	5	6	7
4. Appropriate connections were made from the science content to real world science contexts through the C.R.E.A.T.E. process	1	2	3	4	5	6	7
5. The session reflected the way science is done	1	2	3	4	5	6	7
6. Relevant science concepts were explicitly addressed in the lesson to promote a deeper understanding of content	1	2	3	4	5	6	7
7. Other (describe):	1	2	3	4	5		

B. Synthesis Ratings

1	2	3	4	5
Science content was not at all present during session				Science content was very present during session

Describe science content:

C. Supporting Evidence for Synthesis Ratings

Appendix B

C.R.E.A.T.E. Anonymous Student Survey

What you think about the C.R.E.A.T.E. model for learning science through the study of scientific research articles is important to the evaluation of C.R.E.A.T.E. as a program for widespread dissemination. However, you may choose to opt out of doing this survey. Your science professor will *not* have access to completed surveys or these survey results.

Please check the space or write-in whatever best describes you:

- Gender? F M
- Are you a person of ethnic or cultural diversity? Yes No
- Year in College 1st 2nd 3rd 4th Other?
- Major: _____

Please read carefully; circle your response to these survey items (“5” is highest).

	<u>Poor</u>				<u>Great</u>
1. I would rate my feelings about science before this course as...	1	2	3	4	5
2. I would rate my feelings about science at this point in the course as...	1	2	3	4	5
3. I would rate my ability to read, understand, & analyze scientific articles before this course as...	1	2	3	4	5
4. I would rate my ability to read, understand, & analyze scientific articles currently as...	1	2	3	4	5
5. I would rate my understanding of the nature of science before this course as...	1	2	3	4	5
6. I would rate my understanding of the nature of science at this point in the course as...	1	2	3	4	5
7. I would rate my understanding of the science content in this course as...	1	2	3	4	5
8. I would rate my experiences with the C.R.E.A.T.E. method in this course as...	1	2	3	4	5
9. I would rate my professor’s ability to teach science using the C.R.E.A.T.E. method as...	1	2	3	4	5
10. This course has contributed positively toward my decision to pursue science as a career...	1	2	3	4	5

Please respond fully to the open-ended questions on the back of this paper.

11. What aspects of C.R.E.A.T.E. have you liked best? Please state your reasons.

12. What aspects of C.R.E.A.T.E. have you liked least? Please state your reasons.

13. How do you feel overall about the C.R.E.A.T.E. method of instruction and your science learning in this course in comparison to the instruction and your learning in other science courses?

Thank you for your time and the sharing of your thoughts concerning C.R.E.A.T.E.

Appendix C

Interview Protocol for C.R.E.A.T.E. Implementers

Requirements for Interview: A quiet, comfortable location where you won't be disturbed. Place the respondent at ease. Ask first about their backgrounds.

Where did you get your doctorate? _____

How many years have you been teaching higher education? _____

What is your current status/rank at your college? _____

1. Please tell me about the course in which you implemented C.R.E.A.T.E..

Probes:

--Have you taught the course previously using a different method?

--What is your impetus for changing your teaching methodologies that led to your participation in the C.R.E.A.T.E. project?

2. What were the benefits of using C.R.E.A.T.E. in your course?

3. What were the difficulties or challenges encountered using C.R.E.A.T.E.?

4. How did you integrate the "nature of science" into your course?

5. In your judgment, what was the general status of your students prior to their enrollment in your course related to:

--Science content knowledge?

--Understanding of the nature of science?

--Ability to read, understand, and analyze a scientific article?

[Note: can use Scale of 1-5 on #5 & #6 if short on time]

6. In your judgment, have your students' understandings in each of the above areas changed as a result of using C.R.E.A.T.E. in your classroom?

7. What about your own knowledge and beliefs? Have they changed as a result of using C.R.E.A.T.E.?

8. Would you use C.R.E.A.T.E. again in this course?

--What modifications would you make, if any?

--Would you use C.R.E.A.T.E. in another course? What course(s)? Why?

--At what level do you think C.R.E.A.T.E. would be most beneficial?

9. What are your favorite aspects of C.R.E.A.T.E.? Your least favorite?

10. Would you advocate C.R.E.A.T.E. to other science colleagues as a method of teaching science? Would you advocate C.R.E.A.T.E. to colleagues not in science as a method of teaching other disciplines? Why or why not?

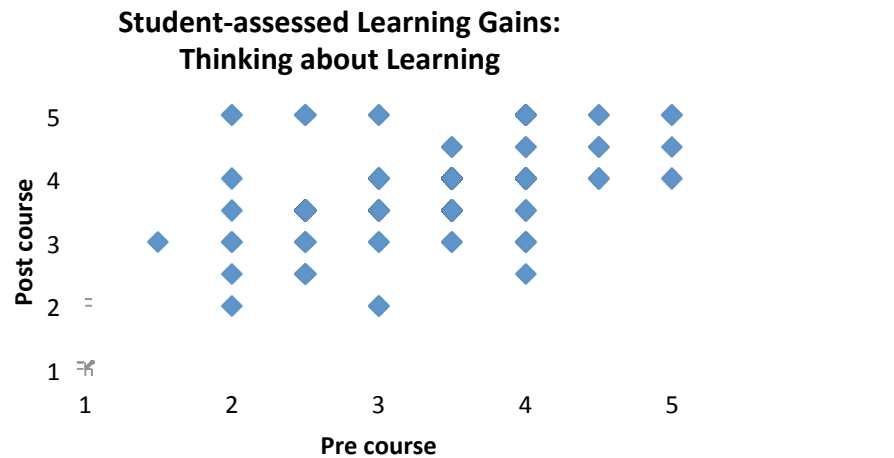


Figure S1. Pooled outcomes from two of the “Integration” subset of four SALG statements. The two statements were (4.2) “Thinking about whether I am fully understanding what I am reading” and (4.3) “Thinking about ‘how I know what I know’, while studying”. These specifically address areas of metacognitive thinking. Positive changes here suggest that students have made gains in their study approaches that arguably could transfer to their approaches to future courses. Pooled SALG data from six CCs, n = 85 students.

Table S1. OE Evaluation of CREATE Implementation in Community College Courses

College	Percent Class Time Centered on Students*	Course Type (Number of Students)	Total Number of CREATE Tools/Activities** Used	CREATE Tools and Activities
Community College 1	50%	Principles of Biology II (35)	10	Using primary literature, concept mapping, annotating, student explanations, small group discussions, analyzing articles in parts, grant panels, contacting authors, small group learning, and transforming data
Community College 2	18%	Marine Biology (33)	11	Using primary literature, concept mapping, student explanations, small group discussions, students presenting, grant panels, small group learning, designing the next experiment, cartooning, transforming data, and translating sentences
Community College 3	50%	General Biology (16)	11	Using primary literature, concept mapping, student explanations, small group discussions, students presenting, grant panels, small group learning, designing the next experiment, cartooning, transforming data, and translating sentences
Community College 4	100%	Molecular Biology (6)	12	Using primary literature, concept mapping, student explanations, small group discussions, planning next step, annotating, students presenting, grant panels, small group learning, cartooning, transforming data, and proposal reviewing
Community College 5	66%	Introduction to Biology (11)	12	Using primary literature, concept mapping, student explanations, small group discussions, students presenting, grant panels, contacting authors, proposal reviewing, analyzing article in parts, small group learning, cartooning, and translating sentences
Community College 6	43%	Introduction to General Psychology (15)	9	Using primary literature, concept mapping, student explanations, cartooning, small group discussions, students presenting, small group learning, annotating, and analyzing articles in parts

*Note that percentages are based on averages of data collected from three site visits. At community college 4, the course was lab-based, with the faculty member facilitating each observed session.

** The OE protocol included fifteen different tools and activities specific to the CREATE strategy (see Supplemental Methods).

Table S2. EDAT Outcomes on Individual CC Campuses.

EDAT outcomes—individual campuses					
CC	N	Pre ave (SD)	Post ave (SD)	Wxn	ES
1	27	4.42 (1.74)	4.72 (2.02)	ns	0.17
2	25	4.00 (1.26)	4.78 (2.15)	0.0414	0.45
3	13	2.73 (2.46)	3.07 (2.86)	ns	0.15
4	5	4.80 (1.48)	4.20 (2.17)	ns	0.32
5	14	2.39 (2.13)	4.43 (2.06)	0.0034	0.95
6	12	2.08 (2.13)	2.08 (1.92)	ns	0

Outcomes must be interpreted with caution due to small sample sizes. On two of the six campuses significant gains were seen during the CREATE term; effect sizes moderate to large. Wxn = Wilcoxon signed-rank test; ES = effect size. (<http://vassarstats.net/wilcoxon.html>).

Table S3. CTT Outcomes on Individual CC Campuses

CTT outcomes									
CC	N	Logical pre-avg (SD)	Logical post-avg (SD)	<i>t</i> -test	ES	Illogical pre-avg (SD)	Illogical post-avg (SD)	<i>t</i> -test	ES
1	23	1.4 (1.02)	1.2 (1.00)	0.156	0.19	0.6 (0.71)	0.4 (0.54)	0.009	0.32
2	22	0.8 (0.91)	1.1 (1.08)	0.042	0.30	1.1 (0.88)	1.1 (0.95)	0.571	0.00
3	12	0.7 (0.78)	1.1 (0.82)	0.002	0.50	1.4 (0.75)	1.0 (0.79)	0.007	0.39
4	5	2.2 (1.4)	2.0 (0.77)	0.487	0.18	0.35(0.54)	0.1 (0.28)	0.035	0.62
5	13	0.8 (0.86)	0.7 (0.89)	0.305	0.11	1.2 (0.76)	1.3 (0.81)	0.423	0.13
6	12	0.7 (0.65)	0.7 (0.62)	0.278)	0.00	0.7 (0.65)	0.9 (0.63)	.152	0.3

Outcomes must be interpreted with caution due to small sample sizes. On four of the six campuses, and in four of the five Biology courses (CC 1-5), students made significantly more logical statements, significantly fewer illogical statements, or both, with small to moderate ES (significant outcomes bolded). These findings support the conclusion that students made cognitive gains during their CREATE courses. *t*-test = paired *t*-test (Excel); ES, Effect size.

Table S4. Student Responses to OE Survey

Perceptions of CREATE Tools and Activities				
Aspect of CREATE	Total mentions		% Positive	% Negative
Concept Mapping	47		62%	38%
Cartooning	44		70%	30%
Promotion of general understanding	35		63%	37%
Group Activities	33		88%	12%
Use of Primary Literature	28		68%	32%
General Create Approach	27		70%	30%
Format/Structure of Course	25		60%	40%
Lecture*	19		58%	42%
Other Tactics**	17		65%	35%
Annotating	10		50%	50%
Transferable Skill	6		100%	0%

*Some students noted explicitly that they preferred CREATE to traditional lecture classes, or that they liked the fact that their CREATE course “wasn’t lecture.” Both counted as a ‘positive’ aspect of CREATE. Others stated that they would have preferred a lecture course (counted as a ‘negative’ aspect of CREATE).

** Several features, such as the homework load and notebook/portfolio creation, received fewer than four mentions each. These are aggregated in the “Other Tactics” category, and, likewise, characterized as either positive or negative.