

ARTICLE

“C.R.E.A.T.E.”-ing Unique Primary-Source Research Paper Assignments for a Pleasure and Pain Course Teaching Neuroscientific Principles in a Large General Education Undergraduate Course

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A large (250 registrants) General Education lecture course, Pleasure and Pain, presented basic neuroscience principles as they related to animal and human models of pleasure and pain by weaving basic findings related to food and drug addiction and analgesic states with human studies examining empathy, social neuroscience and neuroeconomics. In its first four years, the course grade was based on weighted scores from two multiple-choice exams and a five-page review of three unique peer-reviewed research articles. Although well-registered and well-received, 18% of the students received Incomplete grades, primarily due to failing to submit the paper that went largely unresolved and eventually resulted in a failing grade. To rectify this issue, a modified version of the C.R.E.A.T.E. (Consider, Read, Elucidate hypotheses, Analyze and interpret data, Think of the next Experiment)

method replaced the paper with eight structured assignments focusing on an initial general-topic article, the introduction-methods, and results-discussion of each of three related peer-review neuroscience-related articles, and a final summary. Compliance in completing these assignments was very high, resulting in only 11 INC grades out of 228 students. Thus, use of the C.R.E.A.T.E. method reduced the percentage of problematic INC grades from 18% to 4.8%, a 73% decline, without changing the overall grade distribution. Other analyses suggested the students achieved a deeper understanding of the scientific process using the C.R.E.A.T.E. method relative to the original term paper assignment.

Key Words: Reward; addiction; relapse; craving; liking-wanting-needing; food intake; empathy; behavioral economics; fMRI; CREATE

INTRODUCTION

The integration of Neuroscience into the broad undergraduate college curriculum has been an ongoing priority at many colleges and universities. In addition to teaching specific Introductory Neuroscience courses, another successful approach links neuroscientific principles within larger subject areas, including Social Psychology (Flint and Dorr, 2010), Womens' Studies (Mead, 2009), mind and consciousness (Kronemer and Yates, 2012), interdisciplinary perspectives (Crisp and Muir, 2012), Liberal Arts (Ramirez, 2007), literature (Harrington, 2006), and the philosophy and history of science (Hockberger and Miller, 2005).

Rationale for a Pleasure and Pain Course

Bodnar and co-workers (2013) described a neuroscience-based undergraduate Psychology course, Pleasure and Pain, as a non-major, non-prerequisite offering that introduced a wide array and large number (250 enrollment per term) of students to neuro-scientifically grounded topics while also providing interdisciplinary interactions with relevance to larger areas of inquiry. To accomplish close interactions with students, three graduate student Teaching Assistants were joined by undergraduate student Discussion Leaders who previously performed well in the course and received forms of active learning to deepen their academic classroom-based learning (Qualters, 2010). The Pleasure and Pain course was designed to upgrade

General Education at Queens College through the City University of New York (CUNY) Pathways initiative. This initiative placed emphasis on the teaching of science-based lecture courses that stressed content, scientific methods, critical thinking, and writing in the sciences. The Psychology Department at Queens College has always resided in the Mathematics and Natural Science Division, and with Biology provided the academic home to the only free-standing undergraduate Neuroscience Major at CUNY. This program, together with a successful Master's Program in Behavioral Neuroscience and a long-standing campus-based CUNY Neuropsychology Doctoral Sub-Program, has produced many successful professionals in the fields of basic Neuroscience and clinical Neuropsychology. Thus, Queens College and the Psychology Department were well-positioned to support a non-major General Education Pleasure and Pain neuroscience-based course.

Although a large public college, Queens College has rarely offered large-scale classes. Table 1 shows that our 250-seat course had near-maximal registration over the last five spring semesters to four different groups of students: Psychology Majors, Majors in other departments within the Mathematics and Natural Science (MNS) Division, Majors in other (Arts and Humanities, Social Science and Education) academic divisions, and Undeclared Majors. As a General Education course, we observed larger proportions of undeclared students

attracted to the course. Whereas consistent enrollment patterns were observed for Majors in other departments within the MNS Division (3.9-12.3%) and Majors in other Academic Divisions (19.0-21.2%), initial Psychology Major enrollment (36.4-45.2%) declined over the past three years to 22.6-28.1%. In contrast, Undeclared Majors enrollment steadily rose from 30% (2011) to almost 50% (2014-2015). Thus, approximately 70% of students not currently majoring in science-related areas enroll in this Neuroscience-based course.

The Curriculum

As already described (Bodnar et al., 2013), the course introduced students to the psychological, philosophical, biological, neurochemical, sociological and evolutionary facts, principles, and theories underlying the concepts of pleasure and pain. In addition, the course linked these to basic neuroanatomical and pharmacological mechanisms mediating pleasure and pain, inclusive of food intake, addiction, pain and pain inhibition, as well as translational implications related to human psychopathological and neurological disorders. In its first four years, course grading was based on multiple-choice mid-term and final examinations, and a five-page research paper examining three assigned unique but related primary-source, peer-reviewed, neuroscience research papers. The paper was due in the last few weeks of the course.

The Original Assigned Research Paper

Assignment of a primary-source research paper is quite rare at Queens College both within the introductory and second-level Psychology courses, and in introductory courses in other disciplines. However, it was included in the course to satisfy ambitious CUNY General Education requirements in the Scientific World requirement by utilizing primary- and secondary-source materials to understand and synthesize information among theories and data

Major	Year	Letter Grade (A, B, C, D, F, and INC)						Total	% Class
		A	B	C	D	F	INC	Total	% Class
PSY	2011	14	33	33	5	0	15	104	45.2%
	%	13.5%	31.7%	31.7%	4.8%	0.0%	14.4%		
	2012	33	26	12	5	1	10	83	36.4%
	%	40.0%	31.3%	14.4%	6.0%	1.2%	12.0%		
	2013	23	15	6	2	0	6	52	24.5%
	%	44.2%	28.9%	11.5%	3.8%	0.0%	11.5%		
	2014	13	9	7	0	0	9	38	22.6%
	%	34.2%	23.7%	16.4%	0.0%	0.0%	23.7%		
	2015	17	26	13	4	0	3	64	28.1%
	%	26.6%	40.6%	20.3%	6.3%	0.0%	4.7%		
	Total	100	109	71	16	1	43	341	
	%	29.3%	32.0%	20.8%	4.7%	0.2%	12.6%		
MNS	A	B	C	D	F	INC	Total	% Class	
	2011	2	7	1	0	0	2	12	5.2%
	%	16.6%	58.3%	8.3%	0.0%	0.0%	16.6%		
	2012	3	6	4	1	0	1	15	6.6%
	%	20.0%	40.0%	26.7%	6.7%	0.0%	6.7%		
	2013	7	12	2	1	0	4	26	12.3%
	%	26.9%	46.2%	7.7%	3.8%	0.0%	15.4%		
	2014	1	3	1	1	0	7	13	7.7%
	%	7.7%	23.1%	7.7%	7.7%	0.0%	53.8%		
	2015	2	2	3	0	1	1	9	3.9%
	%	22.2%	22.2%	33.3%	0.0%	11.1%	11.1%		
	Total	15	30	11	3	1	15	75	
	%	20.0%	40.0%	14.7%	4.0%	1.3%	20.0%		
Other	A	B	C	D	F	INC	Total	% Class	
	2011	6	19	15	2	0	3	45	19.6%
	%	13.3%	42.2%	33.3%	4.4%	0.0%	6.7%		
	2012	10	23	7	2	0	4	46	20.2%
	%	21.7%	50.0%	15.2%	4.3%	0.0%	8.6%		
	2013	15	16	5	1	0	8	45	21.2%
	%	33.3%	35.6%	11.1%	2.2%	0.0%	17.8%		
	2014	5	13	7	0	0	7	32	19.0%
	%	15.6%	40.6%	21.9%	0.0%	0.9%	21.9%		
	2015	5	16	9	11	1	3	45	19.7%
	%	11.1%	35.6%	20.0%	24.4%	2.2%	6.7%		
	Total	41	87	43	16	1	25	213	
	%	19.2%	40.8%	20.2%	7.5%	0.4%	11.7%		
UND	A	B	C	D	F	INC	Total	% Class	
	2011	8	19	21	5	0	16	69	30.0%
	%	11.6%	27.5%	30.4%	7.2%	0.0%	23.2%		
	2012	20	22	17	2	0	23	84	36.8%
	%	23.8%	26.2%	20.2%	2.4%	0.0%	27.4%		
	2013	22	30	18	2	0	17	89	42.0%
	%	24.7%	33.7%	20.2%	2.2%	0.0%	19.1%		
	2014	6	41	21	0	1	16	85	50.6%
	%	7.1%	48.2%	24.7%	0.0%	1.2%	18.8%		
	2015	20	40	28	12	6	4	110	48.2%
	%	18.2%	36.4%	25.5%	10.9%	0.9%	3.6%		
	Total	76	152	105	21	7	76	437	
	%	17.4%	34.8%	24.0%	4.8%	1.6%	17.4%		
Total/Yr	A	B	C	D	F	INC	Total		
	2011	30	78	70	12	0	36	230	
	%	13.0%	33.9%	30.4%	5.2%	0.0%	15.7%		
	2012	66	77	40	10	1	38	228	
	%	28.9%	33.8%	17.5%	4.4%	0.4%	16.7%		
	2013	67	73	31	6	0	35	212	
	%	31.6%	34.4%	14.6%	2.8%	0.0%	16.5%		
	2014	25	66	36	1	1	39	168	
	%	14.9%	39.3%	21.4%	0.6%	0.6%	23.2%		
	2015	44	84	53	27	8	11	228	
	%	19.3%	36.8%	23.2%	11.8%	3.5%	4.8%		
	Total	232	378	230	56	10	159	1066	
	%	21.8%	35.5%	21.6%	5.3%	0.9%	14.9%		

Table 1. Grade distributions as a function of enrollment patterns for 2011-2015 years in four categories: Psychology (PSY Majors), Majors in other Mathematics and Natural Science (MNS) Division departments, Majors in Arts and Humanities, Social Science and Education Divisions (Other), and Undeclared (UND) Majors. **Bold** frequencies and percentages display effectiveness of the C.R.E.A.T.E. process.

as they related to pleasure and pain. This five-page paper assignment mixed expository and transactional writing styles, and asked the student to synthesize the three primary-source articles by indicating the overarching research hypotheses and theories, the employed techniques and results, and data interpretation in terms of the hypotheses. Students chose one of the following topic areas early in the term: neuroanatomy-neurochemistry of motivation; neuroanatomy-neurochemistry of analgesia; drug addiction and craving; food addiction and conditioned flavor preferences; roles of needing, wanting and liking related to pleasure; opiate analgesic systems; roles of stress and sex differences in analgesia; and neuro-economic issues related to Pleasure and Pain. Three unique primary-source articles (~4-8 pages) by prominent researchers in the topic areas were assigned to each student. The paper introduced the general principles of the selected topic (1 page), described hypotheses, methodologies and results of each of the assigned articles (1 page each, 3 pages), and synthesized principal findings and interpretations (1 page).

Assessment of Outcomes of the Original Grading Structure

The course enjoyed low withdrawal rates (2011: 18/248, 7.3%; 2012: 15/243 6.2%; 2013: 21/233, 9.0%; 2014: 15/183, 8.2%) and stable grade distributions across groups (Table 1). Grades of A understandably appeared greater in the Psychology Majors (29.3%) than in the other three groups (20.0%, 19.2% and 17.4%). Grades of B were higher in the Other Science Majors (40%) and Majors from other Academic Divisions (40.8%) than Undeclared Majors (34.8%). Grades of C, D and F appeared comparable across all four groups. However, one troubling pattern emerged in the first four years (Table 1), a high consistent level of Incomplete (INC) grades: 2011 (36/230, 15.7%), 2012 (38/228, 16.7%), 2013 (35/212, 16.5%), 2014 (39/168, 23.2%). The overall 18% INC rate was primarily due to failure to submit the required paper, resulting in severe consequences. Only 13 (~10%) of 148 students successfully rectified their INC within the institutionally-allotted time of the end of the next semester, leaving the remaining 135 students with an automatic reversion of the INC grade to a failing (FIN) grade with Undeclared Majors (72/327, 22%) and the Other Science Majors (14/62, 22.6%) displaying higher patterns of INC grades than Psychology Majors (40/277, 14.4%) and Majors from other Academic Divisions (22/170, 12.9%).

Three issues were identified to account for this problem. First, a General Education course with no pre-requisites might attract many students with little or no background in writing a primary-source scientific research paper. That would certainly be true for the Undeclared Major Group. The INC rate in the Other Science Major group could be explained by dependence of other science disciplines on laboratory exercises, and not term papers as a grading rubric. The lower number of INC grades in Majors from other Academic Divisions could be attributed to reliance on primary-source term papers for grading rubrics. Finally,

Psychology Majors with required courses in Statistics and Experimental Psychology may be better prepared for this task. Second, many students failed to request guidance in constructing such a paper from the Graduate TA's despite their availability in office hours, reflecting an inability to "ask the right question," or to put it more simply, "know what you don't know," and then "ask questions." This point was confirmed by the observation of a failure to use Discussion Leader expertise with less than 50% of the students participating in voluntary discussion groups despite the chance to discuss the paper and earn four extra points towards their final grade. The third possibility was a common malady – simple procrastination. Although the students received their assignments early in the semester, it was found that many polled students delayed starting the paper until it became too late and too difficult.

A major question is why didn't this significant cohort of INC students simply withdraw from the class, and thereby suffer no academic penalty. A "social" explanation is that students don't recognize their predicament until it is too late. Another answer is "economic" because Queens College serves many students of modest means and low family income. Over 45% of undergraduate Queens College students receive federal Pell grants and/or New York State Tuition Assistance Program (TAP) funding. Over 85% of undergraduates attend the college full-time (12 credits/semester), but over 50% have an outside job of 20 or more hours per week. Moreover, over 50% of the students are transfers from neighboring community colleges in the CUNY or SUNY systems. Reliance on Pell and TAP funding exposes students to the vagaries of the system in that course withdrawal presents economic difficulties in the form of repayment of funds.

These persistent and stubbornly high rates of INC grades in an otherwise successful Neuroscience-related course were vexing and unsustainable. The question then became whether we would sacrifice a laudable goal of the course by relinquishing the research paper or whether we could employ an alternative strategy that would accomplish the same aims, and reduce the incidence of INC grades by using a modification of the C.R.E.A.T.E. method.

The C.R.E.A.T.E. Method

The sheer volume of scientific discoveries makes the traditional teaching of content learning in the life sciences problematic (Alberts, 2005), and leads to both attrition (Seymour and Hewitt, 1997) and dissatisfaction (Osborne, 2003; Lawson et al., 2007) with pure content-based scientific teaching. Sally Hoskins and colleagues have developed a method in which primary-source peer-reviewed literature served as a medium in which to understand the scientific research process: C.R.E.A.T.E. (Consider, Read, Elucidate hypotheses, Analyze and interpret data, Think of the next Experiment) (Hoskins, 2008, 2010; Hoskins et al., 2007). Offered originally in small, advanced Biology courses at CUNY, the method abandoned a linear content-based review of extant scientific findings in a particular field, and instead focused on a small subset (e.g., 4-6 chosen primary-source peer-

review articles in a semester). This process presented a background lecture on the general subject followed by dissection of 3-5 primary-source articles by the students. This method included thorough analysis of hypotheses, detailed evaluation of methodology (using diagrammatic replications of the procedures and experimental and control groups), detailed description of the figures based on importance, evaluation of the results based on the figures, and evaluation of the discussion based on the figures and results. The students are then asked to design follow-up studies in grant-like formats that are judged by "grant panels" as well as generation of questions answered in e-mail surveys sent to the authors. At the end of the course, all of the papers are discussed together with the authors' responses. This method was recently successfully adapted for small classes of STEM-interested freshmen (Gottesman and Hoskins, 2013).

The C.R.E.A.T.E. Method and Primary-Source Peer-Reviewed Articles in the Pleasure and Pain Course

To retain a content-based curriculum that included detailed consideration of primary-source articles examining neuroscientific principles and facts among basic, applied and interdisciplinary topics, we chose to adopt a portion of the strategies employed by the C.R.E.A.T.E. method. The second lecture of the course introduced this method along with salient information relating to definitions of primary-, secondary- and tertiary-source literature, deductive and inductive scientific approaches, levels of ideas (models, theories, hypotheses), types of scientific research (observational, correlational, experimental), independent and dependent variables, how to comprehend figures, and

scientific paper sections. The students were then given a choice of six topics and neuroscience authors covered in the Pleasure and Pain course (Table 2), and were then assigned a general newspaper or magazine article featuring the author's research and three primary-source peer-reviewed articles by the author in chronological order of publication. The students were then required to complete eight assignments throughout the semester ending one week before the final examination (Table 3).

Each assignment was worth 10 points with the 8 assignments accounting for a total of 80 points (Table 4). Deadlines were enforced to electronically submit the assignment into the Safe-Assign feature of Blackboard (version 9.1), a web-based learning management system to deter plagiarism (Table 3). A 1-point deduction administered for each week that any assignment was submitted late. The minimum score on any completed assignment was 5 (Table 4). Equal grading assignments based on the number of students choosing a particular topic were assigned to the TA's. Grades for each assignment were determined by a rubric developed by the TA's and instructors (Table 4) examining such factors as content coverage, general understanding, writing style and grammar. The rubric was made available to the students after grading allowing feedback and clarification as to why a particular grade was assigned. Additional lists of "missed" and/or common "erroneous" material specific to each assignment and topic were also provided. The students could contact the TA's during office hours to address any questions. The Discussion Leaders dedicated two weeks (1 and 3) to answering general (not specific) questions about the C.R.E.A.T.E. assignments. The other

Topic/Author	Articles List
Liking, wanting and needing food Dr. Kent Berridge	theguardian.com: Word of Mouth Blog (2014). J Neurosci , 25(50): 11777-86, 2005. J Neurosci , 27(7): 1594-1605, 2007. J Neurosci , 34(12): 4239-50, 2014.
Neuroimaging empathy of human pain states Dr. Jin Fan	mountsinai.org: Newsroom: Press Release (2012). J Neurosci , 30(10): 3739-44, 2010. Cereb Cortex, 23: 20-7, 2012. Brain, 135: 2726-35, 2012.
Basic mechanisms of alcohol addiction Dr. George Koob	wsj.com: Wal I Street Journal : News Article (2013). J Neurosci , 26(44): 11324-32, 2006. Brain Res, 1155: 172-8, 2007. Biol Psychiatry, 67(9): 831-9, 2010.
Social modulation of pain states in rodents Dr. Jeffrey Mogil	cbc.ca/news: Canadian Press (2014). Science, 312(5782): 1967-70, 2006. Soc Neurosci , 5(2): 163-70, 2010. Nat Methods, 11(6): 629-32, 2014.
Preferences for simple and complex sugars in rodents Dr. Anthony Sclafani	NYTimes.com: Body NYT NOW (2014). Physiol Behav, 32(2): 169-74, 1984. Neurosci Biobehav Rev, 11(2): 215-22, 1987. Am J Physiol Integr Comp Physiol , 296(4): R866-76, 2009.
Oxytocin as a "trust" and "affiliative" molecule in humans Dr. Paul Zak	wsj.com: Wal I Street Journal : The Saturday Essay (2012). Horm Behav, 60(2): 148-51, 2011. Altern Ther Health Med, 18(6): 11-18, 2012. Exp Clin Psychopharmacol , 21(2): 85-92, 2013.

Table 2. C.R.E.A.T.E. assignment topic preferences.

Assignment	Questions Rubric
Assignment #1 General Article Summary (Due Week 3)	(1) What is the major objective of the article in relation to the general field of pleasure and pain? (2) How does the general article summarize the specific work of the researcher?
Assignment #2 Article #1: Abstract, Introduction and Methods (Due Week 5)	(1) Summarize the background of the article, and how does it relate to the general article? (2) State the specific hypotheses to be tested. (3) Identify the dependent variable(s) and how they are measured. (4) Identify the independent variable(s) and how they are manipulated. (5) Identify any variables that are controlled (e.g., gender, time of test, one area of the brain). (6) Diagram how the study was done (you may include anything such as boxes, arrows, clip-art, etc.).
Assignment #3 Article #1: Results and Discussion (Due Week 7)	(1) Identify and describe what you think is the most important figure. (2) Identify and describe what you think is the second most important figure. (3) Identify and describe what you think is the third most important figure. (4) Briefly describe the most important findings. (5) Did the study confirm the hypotheses and how?
Assignment #4 Article #2: Abstract, Introduction and Methods (Due Week 9)	(1) Answer the six questions stated in Assignment #2. (2) How did Article #2 "differ" from Article #1 and why?
Assignment #5 Article #2: Results and Discussion (Due Week 11)	(1) Answer the five questions stated in Assignment #3. (2) How did the results of Article #2 add to the knowledge of Article #1?
Assignment #6 Article #3: Abstract, Introduction and Methods (Due Week 12)	(1) Answer the six questions stated in Assignment #2. (2) How did Article #3 "differ" from Articles #1 and #2 and why?
Assignment #7 Article #3: Results and Discussion (Due Week 13)	(1) Answer the five questions stated in Assignment #3. (2) How did the results of Article #3 add to the knowledge of Articles #1 and #2?
Assignment #8 Synthesis and Summary of All Previous Assignments (Due Week 15)	(1) Summarize the overall findings. (2) How did the three peer-review articles support or fail to support the statements in the general article? (3) In 3-5 sentences, describe what you would do next?

Table 3. C.R.E.A.T.E. assignments and questions rubric.

Numeric Score	Letter Score	Grading Criteria
10	A	Student did a superb job in summarizing all of the major points/questions and the assignment was well-written.
9	A	Student made good efforts to address all of the major points/questions and the assignment was well-written.
8	B	Student addressed a majority of the major points/questions and the writing style was satisfactory.
7	C	Student addressed about one-half of the major points/questions and the writing was style satisfactory.
6	D	Student carelessly touched on a few (1-2) of the major points/questions and the writing style was poor.
5	F	Student did not address correctly any of the major points/questions and the writing style was poor.
0	F	Student failed to complete the assignment
Deduction		Deduction Criteria
-1		Assignment is one-week late
-2		Assignment is two-weeks late
-5		Assignment is over two-weeks late

Table 4. C.R.E.A.T.E. assignment grading and point deduction rubric.

two Discussion Weeks (2 and 4) occurred just prior to the mid-term and final exams, and were used to answer review questions.

Assessment of Outcomes of the C.R.E.A.T.E. Method

The adaptation of the C.R.E.A.T.E. method to this course addressed the failure of students (~18% INC rate) in submitting the original research paper. We believe it addressed the lack of experience, lack of requesting guidance in constructing such a paper, and procrastination. An early lecture dedicated to description of the method, and background information related to scientific approaches, definitions of variables and description of experimental design provided students with the process by which they could begin to ask intelligent and insightful questions. The fact that they had to choose a topic immediately, and then initially work on a general lay-reader level article eased them into the process, and had the students working toward a short-term rather than distant deadline. The subsequent assignments with their attendant deadline dates were designed to reduce procrastination. Moreover, the Discussion groups allowed the students to see that they were not alone in having their questions addressed. The TA's use of feedback corrected student misconceptions, and improved performance on subsequent assignments. The ability to read portions of each article singly and then answer structured questions, allowed them to break down the assignment from a large impersonal process to a more dynamic and active learning process.

Compliance by the students in the first three assignments was initially quite high (over 90%), but we began to see dwindling participation around the fourth, fifth and sixth assignments. We countered this by repeated instructor announcements in every class and Blackboard postings that it was in the student's best interest to hand in every assignment even if they were late given the grading system assigning a "failing grade" of 5 points out of 10, whereas a missing assignment was awarded a 0 score.

The C.R.E.A.T.E. Method Improved Student Completion and Understanding

In the first four years of an otherwise successful Pleasure and Pain course, we identified a stubbornly persistent cohort of about 18% INC grades due primarily to a failure to submit the end-of-semester research paper. Using an adapted C.R.E.A.T.E. method in the Spring, 2015 semester; only 11 of 228 students (4.8%) received INC grades. Comparison of this percentage of INC grades with those of the first four years (15.7%, 16.7%, 16.5%, 23.2%; mean = 18.02%; SD = 3.48, Table 1) resulted in a significant ($p<0.002$) z-score of 3.79 and a 73% decrease in the number of INC grades.

Perusal of the grade distribution indicated these additional facts. First, the withdrawal rate in Spring, 2015 (22) was very similar to the number of withdrawals (15-21) observed in the first four years, indicating that the more immediate demands of the assignments did not chase students out of the course. Second, the distribution of A, B and C grades remained quite consistent in 2015 (79.3%)

relative to 2011 (79.3%), 2012 (80.2%), 2013 (80.6%) and 2014 (75.6%) terms. There was an increase in the awarding of D grades in 2015 (11.8%) relative to the mean of the previous four years (3.3%), but even in this case, the students completed the course with a passing grade. These D grades were earned primarily because of either very late submission or non-submission of C.R.E.A.T.E. assignments. Finally, eight F grades were awarded because of poor performance on the exams, and/or late or non-submission of the paper assignments.

In addition to the sharp reduction in awarded INC grades, we quantitatively examined whether use of successive assignments improved performance in understanding issues related to the Introduction and Methods sections of the three papers (Assignments 2, 4 and 6) and to the Results and Discussion sections (Assignments 3, 5 and 7). Of the 217 students who successfully completed the course in the Spring, 2015 semester, 101 students (46%) completed these six assignments on time. We divided these students into cohorts receiving 9-10 (n=71), 7-8 (n=22) or 5-6 (n=8) on Assignment 2, and then compared performance on Assignments 2, 4 and 6 and Assignments 3, 5 and 7 using repeated-measures analyses of variance. Significant increases in grades for the Introduction and Method sections across the three papers were noted for students receiving initial 5-6 grades ($F(2,14)= 8.78$, $p<0.034$): #2 (5.5 ± 0.2), #4 (8.0 ± 0.5), #6 (7.4 ± 0.7) and initial 7-8 grades ($F(2,42)= 6.29$, $p<0.041$): #2 (7.6 ± 0.1), #4 (7.9 ± 0.2), #6 (8.4 ± 0.2). A small but significant decrease in grades for this measure was observed for students receiving initial 9-10 grades ($F(2,140)= 22.17$, $p<0.0001$): #2 (9.4 ± 0.1), #4 (8.8 ± 0.1), #6 (8.8 ± 0.1). Significant increases in grades for the Results and Discussion sections across the three papers were noted for students receiving initial 9-10 grades ($F(2,140)= 5.51$, $p<0.005$): #3 (8.74 ± 0.2), #5 (9.1 ± 0.1), #7 (9.2 ± 0.1), but not for initial 5-6 grades ($F(2,14)= 2.00$): #3 (7.9 ± 0.7), #5 (8.9 ± 0.4), #7 (7.9 ± 0.7) and initial 7-8 grades ($F(2,42)= 0.55$): #3 (8.36 ± 0.3), #5 (8.0 ± 0.3), #7 (8.1 ± 0.3). Thus, these initial quantitative data demonstrate that the C.R.E.A.T.E. method resulted in improved and/or stable performance in interpreting primary-source, peer-review articles. These preliminary quantitative observations in the first year of C.R.E.A.T.E. implementation will be followed up with further analyses in subsequent years.

Several qualitative measures also supported this contention of improved performance as the assignments progressed. The Graduate TA's graded the original term paper in the first four years, and also graded the eight individual assignments using the previously-described rubrics (Table 4). By bringing the C.R.E.A.T.E. process into our class, we were able to introduce students to the research process in a much more intimate fashion. It taught the students "a learning process," instead of inundating them with scientific research they have never seen before and expecting them to write a paper. Generally speaking, conscientious students who initially researched which author that they chose and asked questions prior to and during the process, typically received the highest grades. The more successful

students were generally able to read and understand the given scientific articles in consecutive order, follow the pattern of questions and instructions, and provided concise and relevant answers throughout the process. The less successful students typically fell behind by failing to hand assignments in on time or seek help when needed even when prompted by the instructor or TAs. However, overall, students were much more relaxed about the process compared to the previous years.

The Discussion Leaders also reported a deeper understanding of the issues at hand and some who had participated in previous years as students reported that the present students had a more profound grasp of the assignments in the C.R.E.A.T.E. process vis a vis the typical term paper process. Discussion Leaders reported that when they prepared their own original term paper, it could take up to a month to complete it with a deeper understanding of the complexities of such a paper. They found that students using the C.R.E.A.T.E process had been exposed to the material longer and were asked to dissect it earlier in the semester. So that when it came time to write the final paper it came easily as it was all material that they had already done via their assignments.

In conclusion, the C.R.E.A.T.E. method was very successful in alleviating the number of INC grades in this well-registered undergraduate General Education course. We believe, subject to further student reporting, that it also improved understanding of course material. The method allowed us to retain and indeed enhance the CUNY and Queens College Pathway goals of using primary-source materials, synthesizing information from primary-source articles, and using first-hand neuroscientific methods to elucidate issues related to pleasure and pain in a general education course.

Note: To obtain the syllabus or Powerpoint lectures of this course, contact Dr. Bodnar at Richard.bodnar@qc.cuny.edu.

REFERENCES

- Alberts B (2005) A wakeup call for science faculty. *Cell* 123:739-741.
- Bodnar RJ, Stellar JR, Kraft TT, Loiacono I, Bajnath A, Rotella FM, Barrientos A, Aghanori G, Olsson K, Coke T, Huang D, Luger Z, Mousavi S, Dindyal T, Naqvi N, Kim J-Y (2013) Pleasure and pain: teaching neuroscientific principles of hedonism in a large general education undergraduate course. *J Undergrad Neurosci Educ* 12:A34-A41.
- Crisp KM, Muir GM (2012) Assessing development of an interdisciplinary perspective in an undergraduate course. *J Undergrad Neurosci Educ* 10:A88-A95.

- Flint RW Jr, Dorr N (2010) Social neuroscience at the College of Saint Rose: the art of team teaching in emerging areas of psychological science. *J Undergrad Neurosci Educ* 8:A122-A127.
- Gottesman AJ, Hoskins SG (2013) CREATE cornerstone: introduction to scientific thinking, a new course for STEM-interested freshmen, demystifies scientific thinking through analysis of scientific literature. *CBE Life Sci Educ* 12:59-72.
- Harrington M (2006) Literature and the history of neuroscience. *J Undergrad Neurosci Educ* 5:E5.
- Hockberger PE, Miller RJ (2005) A rationale and outline for an undergraduate course on the philosophy and history of science for life science students. *J Undergrad Neurosci Educ* 4:A12-A16.
- Hoskins SG (2008) Using a paradigm shift to teach neurobiology and the nature of science- a C.R.E.A.T.E.-based approach. *J Undergrad Sci Educ* 6:A40-A52.
- Hoskins SG (2010) "But if it's in the newspaper, doesn't that mean it's true?" Developing critical reading and analysis skills by evaluating newspaper science with C.R.E.A.T.E. *Amer Biol Teach* 72:415-420.
- Hoskins SG, Stevens LM, Nehm R (2007) Selective use of primary literature transforms the classroom into a virtual laboratory. *Genetics* 176:1381-1389.
- Kronemer SI, Yates J (2012) An undergraduate taught course on consciousness and mind. *J Undergrad Neurosci Educ* 11:A17-A21.
- Lawson A, Banks D, Logvin M (2007) Self-efficacy, reasoning ability, and achievement in college biology. *J Res Sci Teach* 44:706-724.
- Mead KS (2009) Sex, gender and the brain: a non-majors course linking neuroscience and women's studies. *J Undergrad Neurosci Educ* 8:A5-A9.
- Osborne J (2003) Attitudes toward science: a review of the literature and its implications. *Int J Sci Educ* 25:1049-1079.
- Qualters, DM (Ed) (2010) Experiential education: making the most of learning outside the classroom. In *New directions for teaching and learning no. 124* (Wehlberg C, Editor-in-Chief) San Francisco, CA: Jossey-Bass.
- Ramirez JJ (2007) Neuroscience and the liberal arts. *J Undergrad Neurosci Educ* 5:E7.
- Seymour E, Hewitt N (1997) Talking about leaving: why undergraduates leave the sciences. Boulder, CO: Westview Press.

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