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Enhancing integrative experiences: Evidence of student perceptions of learning gains from cross-course interactions

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Abstract: This article offers food for thought on a strategy used by seven faculty to enhance students' integrative learning by offering cross-course, cross-disciplinary projects and shared activities focused on food. The faculty teach a cluster of ten courses in natural sciences, health sciences, social sciences and humanities that address food themes. Assessment data illustrate the learning gains by students enrolled in the clustered courses and points to limitations of the strategy as well. The evaluation of the strategy includes a discussion of the costs and benefits of the effort from the perspective of the teaching faculty.

Keywords: integrative learning, liberal arts, general education, food, interdisciplinary, cross-course projects

A hallmark of liberal arts learning and general education is the commitment to the breadth of students' education that goes beyond any particular discipline. Traditional curricula have asked students to choose from a menu of courses in a range of disciplines to fulfill graduation requirements. The assumption has usually been that students themselves will integrate ideas and practices into their lives as learners. Colleges and faculty have made a variety of attempts to provide contexts for that integration during a student's education, including interdisciplinary colloquia, humanities and arts programs, interdisciplinary majors, and more recently, course clusters or learning communities. More than 500 colleges and universities now incorporate course clusters or learning communities into their curricula (Dodge & Kendall, 2004).

In this paper we describe and assess a set of strategies for helping students integrate their learning in a liberal arts/general education context. We call these strategies *cross-course projects* and *cross-course activities*. In a cluster of courses called Food for Thought, we offer a set of courses from disciplines in the natural sciences, health and wellness, the social sciences, and the humanities. During each semester, courses share cross-course projects where students collaborate on joint endeavors. These projects provide a means to enhance knowledge of the subject matter and of learning skills. Students also participate in cross-course activities where, for example, students from different courses attend seminars or tour local farms and food production facilities. We describe our efforts and evaluate their effectiveness using student survey data from three semesters of courses.

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I. Background.

Interdisciplinary learning develops four cognitive abilities: 1) the application and development of perspective-taking techniques; 2) the development of structural knowledge of problems appropriate to interdisciplinary inquiry; 3) the integration of conflicting insights from two or more disciplines; and 4) the production of cognitive advancement or interdisciplinary understanding of a problem. This learning may be assessed through entrance and exit surveys at the beginning and end of the course and can be used in tandem with rubrics developed from course learning outcomes (Repko, 2008).

At the University of North Carolina Asheville (UNCA), interdisciplinary education is effected through clusters of courses that fulfill breadth requirements in the natural and social sciences and also offer depth surrounding a topical theme or issue. This unique approach to general education is most similar to the more inclusive category of learning communities as manifested at other colleges and universities. Learning communities are formed in a variety of ways, but commonly aim to create an enhanced learning environment involving greater intellectual interaction between students and with faculty. This typically involves connecting small groups of students together through co-enrollment in a set of (sometimes thematically-linked) courses or as part of a first year experience (Tinto, 2000b; Hurd, 2004)). Learning communities differ from UNCA's cluster component of Integrative Liberal Studies in that learning communities offer courses that are more rigidly linked to each other's schedules and co-requisites (Tinto 2000b; Hurd, 2004). The UNCA model aims to achieve the demonstrated benefits of learning communities, such as student groups that are move involved in and out of the classroom and an increased sense of responsibility to participate in the learning experience (Tinto, 1997; Landis, 1998; Tinto, 2000a; Driscoll, Gelabert, & Richardson, 2010), without the logistical scheduling restraints that often plague the implementation of successful learning communities (Hurd, 2004).

Regardless of the subtle differences, course clusters, learning communities, and other curricular enhancements that emphasize both interdisciplinary learning and interactions of students and faculty beyond the confines of the classroom are all collaborative learning opportunities. Ample evidence exists for the beneficial effects of collaborative learning opportunities on student learning. All of these curricular innovations are in accordance with a shift in higher education from a paradigm based on instruction to one based on learning (Barr & Tagg, 1995). Gray (2000) cites several examples: 1) Students at University of Northern Colorado enrolled in learning communities had noticeably higher retention into sophomore year and higher first term grade point averages. 2) At Queens College, City University of New York, qualitative and quantitative assessment produced a longitudinal, ethnographic study of the impact of their learning community (Freshman Year Initiative-FYI) on student learning. Students in the FYI progress toward a degree more rapidly than non-FYI students and report more intellectual and personal satisfaction. 3) At the University of Hartford, following implementation of first year interest groups students in first year interest group courses responded favorably compared to students not in first year interest group courses. At other schools, including the University of Washington, LaGuardia Community College in New York City, and Seattle Central Community College, students in learning communities spent more time together outside of class than did students enrolled in traditional courses. Retention increased by 25% at Seattle Central Community College. Students reported an increased sense of responsibility for their own learning as well as that of the other students (Tinto, 2000). Collaboration and team-building

resulted in higher retention at North Seattle Community College (97 percent compared to 70 percent for students not in learning communities; Byrne, 2002). At the University of California at Los Angeles, a cohort of nearly 500 freshmen enrolled in team-taught, interdisciplinary courses termed cluster courses had their experience assessed in comparison with students enrolled in a traditional curriculum (University of California at Los Angeles, 2000). Students, faculty, and teaching assistants all reported enhanced acquisition of skills and satisfaction in cluster classes, but also reported an increased workload in comparison to traditional courses. While the interdisciplinary learning communities cited above generally focus on a well-defined cohort of students (e.g. freshmen or students in a given major), UNCA's interdisciplinary clusters offer the opportunity of bringing together students from different academic levels and majors in a defined set of courses and cross-course activities. This fosters opportunities for mentoring between majors and non-majors, upper level and lower level students, and natural science, humanities, and social science majors.

II. Our Context.

A. Integrative Liberal Studies.

In 2004 UNCA adopted a revised general education curriculum called the Integrative Liberal Studies (ILS) program. In ILS, students take their general education distribution in natural science, social science, and humanities or arts in topical clusters centered on a common theme. Students participate in the cluster by completing three courses from three different disciplines, of which there is at least one science and at least one social science. There are currently 15 topical clusters for students to choose from including Technology, Society, and Culture; The Science and Politics of Human Health and Illness; Latin American Studies; Globalization and Environmental Issues, among others. This paper focuses on one of those clusters, Food for Thought: Engaging the Citizen in the Science and Politics of Food Information, Food Consumerism, Nutrition and Health (Food for Thought). Table 1 describes the 10 courses in this cluster.

B. Food for Thought Cluster and Activities.

The Food for Thought cluster was initiated in 2007, on the impetus of a course development grant received in 2006 through Science Education for New Civic Engagements and Responsibilities (SENCER), an NSF-funded program for "improving undergraduate STEM (science, technology, engineering and mathematics) education by connecting learning to critical civic questions" (SENCER 2010, http://www.sencer.net/About/projectoverview.cfm). The cluster focuses on developing the student as an informed consumer of food by providing a platform for discussion of what we eat, why we eat, where our food comes from and its journey from production to consumption, and how food affects our bodies and health. Students gain insight into the often hidden ways that food consumption impacts us on both the individual and collective levels. As human beings, our bodies and our societies are interlinked by numerous processes, many of which can be understood by investigating the dynamics of food in chemical, biological, cultural and social systems. Our primary goal for students is an enhanced, interdisciplinary understanding of the interplay of these systems and a more attuned sense of how food is a civic issue. More information is available at (http://www.unca.edu/foodforthought/).

Table 1. Food for Thought Cluster Courses.

Discipline Course Title (and Number)	Prerequisites	Requirement Satisfied[a]	Number of students enrolled (semester)
Biology			
Plants and Humans (110)	none	ILSN, ILSE	21 (Spring 2009) 19 (Spring 2010)
Biology of the Seed Plants (335)	8 hours of Chemistry; Intro. Botany; Intro. Ecology	ISLN, ILSE, Biology major	17 (Spring 2009)
Chemistry			
The Food of Chemistry (174)	none	ILSN, ILSE, lab science	19 (Fall 2008)
Economics			
Land Economics (245)	Intro. Macro or Micro Economics	ILSS, ILSE, option in Economics & Environmental Studies majors	20 (Fall 2008) 20 (Fall 2009)
Health and Wellness			
Nutrition and Lifestyle (225)	Intro. Wellness	ILSS, ILSE, Health and Wellness major	30 (Fall 2008) 35 (Spring 2009) 30 (Fall 2009) 57 (Spring 2010)
Pathophysiology of Chronic Conditions and Illnesses (325)	Anatomy or Mammalian Physiology	ILSS, ILSE, Health and Wellness major	38 (Spring 2009) 22 (Fall 2009) 21 (Spring 2010)
Food Politics and Nutrition Policy: How Government and Industry Impact Health (333)	Intro. Wellness	ILSS, ILSE	19 (Fall 2009)
Sociology			
Sociology of Gender (280)	none	ILSS, ILSE, option in Sociology major, Women, Gender and Sexuality Studies major	26 (Spring 2009) 26 (Fall 2009) 19 (Spring 2010)
Science and Technology (385)	none	ILSS, ILSE, option in Sociology major	13 (Fall 2008)
Spanish			
Elementary Spanish for Health Professionals (110/120)	none	ILSE, foreign language	20 (Fall 2009) 21 (Spring 2010)

Together, the faculty teaching in the cluster developed a set of shared learning outcomes that inform not only individual courses in the cluster, but shared learning opportunities among the courses. Each semester faculty teaching in the Food for Thought cluster convene regularly to plan and implement an appropriate set of cluster activities for the courses that are being offered that term. Students engage with the cluster themes by participating in course-specific projects and activities, such as measuring the content of sodium in vending machine foods (chemistry) or studying local food distribution systems (economics, health and wellness); *cross-course cluster projects* that engage students across cluster courses (such as creating a shared meal or devising a social marketing campaign for a nonprofit health promotion organization) and *cross-course cluster activities* that are available to one or more courses in a given semester (such as farm tours and seminar series). This paper focuses on the novel dimensions of our cluster of courses in a general education program – those that involve engagement outside of traditional classroom configurations.

Cross-Course Cluster Projects are integrated, multidisciplinary projects that engage students from multiple cluster courses simultaneously. Table 2 below provides a list of projects. The students must learn how the knowledge from one discipline relates to others in order to successfully complete the project. Through this process, students in a variety of disciplines in the natural sciences, social sciences and humanities interact with one another and benefit from a range of perspectives for addressing a single issue.

One example is the Harvest Bounty Shared Meal. Teams of seven to nine students (from at least three different cluster courses) work together to plan, prepare, consume, and analyze a meal. Teams are required to work within specific constraints (all local, all organic, or all whole foods, or a reduced budget) with the goal of producing a delicious and sustainable meal. The assignment requires teams to analyze cost, energy utilization, nutrients and nutritional balance, social factors, and in some cases cultural appropriateness. To complete the assignments, students in different courses must teach one another nutrition, science, sociology, Latino food culture, and economics. The meals from each group are eaten together, family style, in a university ballroom as a large cluster-wide shared meal.

A second cluster project is the Food & Nutrition Guidelines Project. Students in the Food Politics and Nutrition Policy course oversee the development of a set of food and nutrition guidelines for UNCA. Students become experts in a specific food or nutrition topic then draft and discuss in small committees a recommendation in their expert area. The food policy committees then receive oral or written suggestions from students in the other Food for Thought cluster courses, discuss the guidelines as a class and then produce a set of proposed guidelines that is presented to campus decision-makers.

In order to better understand the complexities of food information, a third cluster project required teams of students from four different cluster courses to research a food source or nutrition-related health issue and to produce a professional poster conveying their information to a consumer audience. These posters and interactive displays are exhibited at UNCA's Symposium of Undergraduate Research and, once judged by a panel of local experts, displayed at the North Asheville Tailgate Market. Through researching plants as food sources, nutritional information and food labeling practices, students learn about the science and policy that shapes food that reaches them in the marketplace. Through constructing a poster and display for a lay audience, students develop skills in conveying information that is research-based in an accessible way.

In one of the semesters studied (spring 2010), there was no cluster-wide project offered due to the impact of the state budget crisis on faculty time and resources.

Cross-Course Cluster Activities vary by semester depending on the courses offered and resources available. See Table 2 below for a list of activities. During two semesters, cluster students went on one or more farm tours, while in two other semesters cluster students toured and/or worked in a campus garden maintained by students, a community garden, and the urban farm of a faculty member. Each semester the cluster also sponsors a "Lunch and Learn" Seminar series. Past seminars have included topics such as soil science, greening the environment with your fork, an introduction to the slow food movement, and chronic disease prevention.

Table 2. Food for Thought Cluster Projects and Activities.

Term	Cross-Course Cluster Projects	Cross-Course Cluster Activities
Fall 2008	Harvest Bounty Shared Meal	Farm Tours
	Food and Nutrition Guidelines	Seminar Series
Spring 2009	Poster Presentations at Undergraduate Research Symposium and North Asheville Tailgate Market	Seminar Series
Fall 2009	Harvest Bounty Shared Meal	Seminar Series
	Social Marketing Campaign Development	Farm Tours
	Food and Nutrition Guidelines	Community Garden Tours
Spring 2010	None	Seminar Series Community Garden Tours

We hypothesize that the various interactions of the students in the cluster have a positive impact on integrative student learning in the areas of academic attitudes, becoming an informed consumer of food, civic engagement, food literacy, research literacy, information and communication skills, and understanding food systems. The purpose of this paper is to report on our process for and findings on whether participation in the Food for Thought cluster enhances integrative student learning.

II. Methodology.

Since the first semester of Food for Thought cluster offerings, we have assessed student learning. The first semester of the cluster, Fall 2008, we used and adapted the SENCER's Student Assessment of Learning Gains (SALG) instrument (http://www.sencer.net/Assessment/assessmenttools.cfm). SENCER developed its adaptable assessment tool to guide educators adopting SENCER philosophy in doing assessment of their individual "SENCERIZED" courses or programs. However, because that instrument is designed for STEM courses, rather than a cluster of courses across disciplines we found it was not adequate for measuring many of the items that we wish to assess. To understand whether the

cross-course projects and cluster activities were having an impact, we needed to develop an instrument designed to measure the cluster (rather than individual course) learning outcomes.

We thus constructed our own entrance and exit survey instrument. The team of cluster faculty met to identify core learning outcomes for the cluster (and therefore, all the courses in the cluster). We then grouped related ones together and constructed questions to address each of the learning outcomes. See Table 3 for general categories of the Food for Thought cluster learning outcomes.

Table 3. Food for Thought Cluster Learning Outcomes.

Learning Outcome	Sample Elements Included in the Outcome
Academic Attitudes	Develop interest in natural and social science fields; develop appreciation for interdisciplinary learning; develop commitment to a major.
Civic Engagement	Develop appreciation of how food consumption and production is a civic issue; identify connection between science and ethics
Informed Consumer	Acquire and use knowledge to make informed food choices; Acquire knowledge about the links between food production and consumption and its relationship to consumers
Interdisciplinary and Disciplinary Skills (Food and Research Literacy	Develop research skills; Develop interdisciplinary understanding of social and biological systems; Understand the scientific method
Information & Communication Skills	Ability to communicate expert knowledge to a lay audience (in a range of fields); Work to solve problems and present information in teams
Food Systems (relationship between) and Social Processes	Understand the science and technology of food production and the development of food policy related to production and distribution
Food Systems (relationship between) and Environmental Systems	Understand the impacts of food production on the environment; Understand the ecological relationship between plants and humans
Food Systems (relationship between) and Individual Health and Wellbeing	Understand where food comes from and how it impacts humans; Plan and prepare a nutritionally balanced meal; Understand the biology of human nutrition

The entrance and exit surveys have 61 items, including: 8 demographic questions, one open-ended question, and 52 questions addressing learning outcomes and course mechanics using a 5-point Likert scale. The learning outcomes questions are organized into four parts: academic attitudes; civic engagement and informed consumer; interdisciplinary and disciplinary skills; and food, food systems, food choices and social and biological relationships. At the end of each survey students were also asked to answer the following open-ended question: "Please list three food issues that interest you most." Students were required by the computer to list three entries in order to complete the survey.

Students in all the cluster courses in each semester were asked to take the entrance survey during the 2nd week of classes (after the add/drop date) and the exit survey in the last week of classes. The survey is offered electronically using quiz form in an internet-based course system (Moodle). Informed consent was provided by all participants following guidelines approved by the Institutional Review Board of UNC Asheville.

Data Analysis

The data analyzed for this report is aggregated data from 3 semesters between fall 2008 and spring 2010. The data for fall 2009 was excluded because the data file from the internet-based survey tool was corrupted.

One-tailed paired Student's t-tests examined differences between entrance and exit survey responses and were conducted using GraphPad Prism 5.0 software (GraphPad Software, Inc.; La Jolla, CA). Only data from students who completed both entrance and exit surveys were included in the analyses. Prior to analysis, the responses to the questions were grouped according to learning objectives listed in Table 3. Grouping reduced the number of statistical tests, and therefore the magnitude of correction for multiple comparisons. The last learning objective, Food Systems, was analyzed both as a group and by each question within the group. Differences were significant when $p \leq 0.0028$ (Bonferroni corrected for multiple comparisons, based on 18 statistical tests). Responses to the open-ended question were coded by assigning each answer to a broad thematic category, and to a corresponding subcategory when the answers were more specific. Responses were assigned to a single category except in cases where multiple categories were implied. A secondary analysis of coded responses indicating an interest in social or individual changes was also conducted.

III. Findings.

A. Sample.

Assessment results were collected from voluntary entrance and exit surveys. One hundred and eighty-six students completed the entrance survey and 153 completed the exit survey over the 3 semesters evaluated (fall 2008, spring 2009, spring 2010). Of those, 106 students completed both surveys, corresponding to 20.7% of enrolled students. Demographic data about the 106 responders is given in Table 4. The composition of respondents is quite similar to the composition of students enrolled in our cluster courses: they are at least sophomore level, of traditional student age, and most frequently social or health science majors. Ninety-one usable responses to the open-ended question were available for analysis (fall 2008, n=37; spring 2009, n=16; spring 2010, n=38).

Table 4. Demographic information of the 106 students who completed both entrance and exit surveys.

	% of survey responses
Female	69.8
College Level	
Freshman	9.4
Sophomore	24.5
Junior	35.9
Senior	30.2
Age (years)	
18 or younger	5.7
19-21	60.4
22-30	30.2
31-40	2.8
41-49	0.9
Over 50	0
Area of college major	
Natural science	14.2
Social science	34.0
Health science	34.0
Humanities	13.2
Undecided	4.6
Grade Point Average (4.0 scale)	
3.60-4.00	34.2
3.01-3.59	44.3
2.51-3.00	16.0
2.01-2.50	4.7

B. Quantitative Results.

The complete list of questions in the entrance and exit survey is included in Appendix A. Mean entrance and exit (open and filled bars, respectively) are given in Figure 1 for six sets of grouped questions from the survey: Academic Attitudes, Civic Engagement, Food Literacy, Research Literacy, Information & Communication Skills, and Food Systems & Choices. Statistically significant differences between entrance and exit survey responses, calculated on a 5-point Likert, are indicated with an asterisk with p-value and mean difference (Δ); *ns* represents no statistical difference in Figure 1.

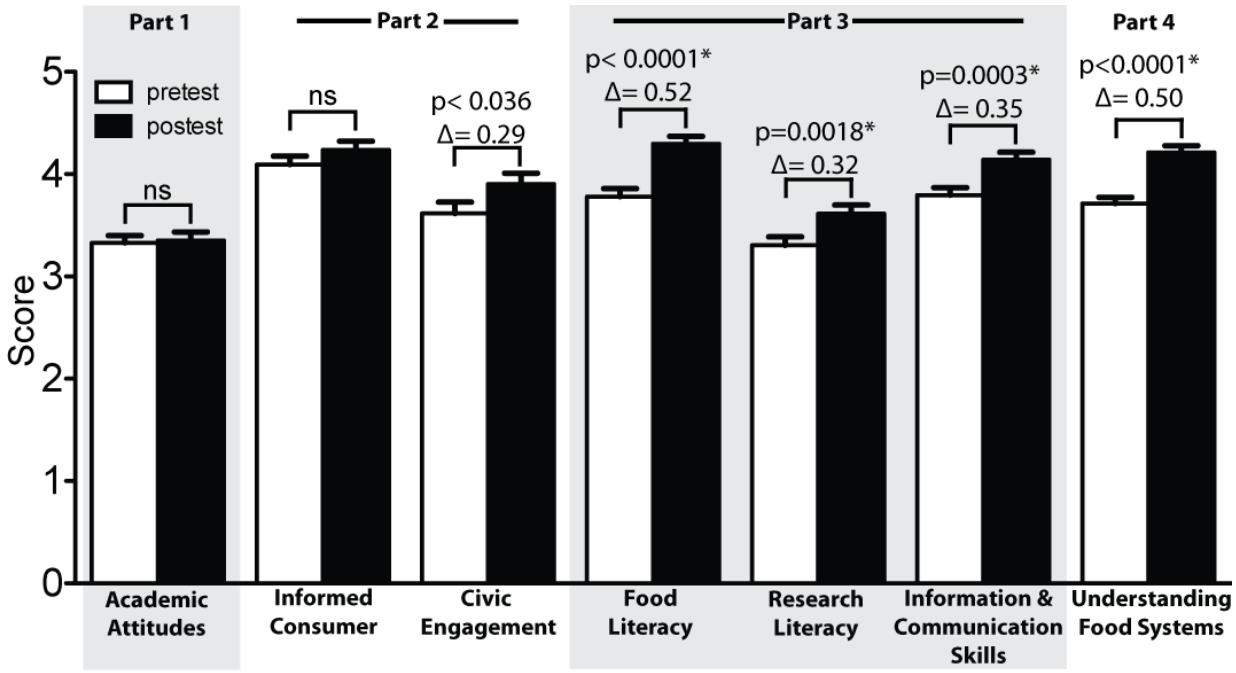

Figure 1. Mean Likert scale responses (with standard error of the mean, positive only) for the major categories in the Food for Thought Assessment Survey. Open bars are entrance survey responses; filled bars are exit survey responses. Statistically significant differences between entrance and exit survey responses are indicated with an asterisk, with p-value and mean difference (Δ); *ns* represents no statistical difference.

Part One of the survey assesses academic attitudes and solicits responses about student interest in being involved in interdisciplinary activities, such as "I am interested in learning in disciplines outside my major" and "I am interested in participating in interdisciplinary projects and activities". Four questions (#10-14 in Part 1, see Appendix A) were grouped to generate the Academic Attitudes result in Figure 1. However, there were no statistically significant changes in the Academic Attitudes.

Part Two of the survey assesses student interest in making deliberate choices as an informed consumer and being involved in civic engagement. The first 6 and last 3 questions focus on whether students are informed consumers and care about making food choices that are, for example, healthy, environmentally sustainable, or emphasize less processing. Analysis of this group of questions yielded an upward trend between entrance and exit surveys, but without statistical significance (shown as Informed Consumer in Figure 1). However, there was a statistically significant increase between entrance and exit on questions related to Civic Engagement, with a mean increase of 0.29 (see Figure 1). The Civic Engagement questions ask students if they cared about participating in collective actions to change food policies, helping others become informed consumers and volunteering for a non-profit working with food.

Part Three of the survey evaluates students' academic skills in the categories of A) Food Literacy, B) Research Literacy, and C) Information & Communication Skills pertaining to food topics. Food Literacy grouped questions such as "understanding labeling on food packaging" and "evaluate the trade-offs involved in purchasing organic, local, unprocessed or fair-trade foods".

Change in Research Literacy was assessed by grouping questions such as "understand how natural/social/health sciences plan and conduct research" and "evaluate the merits of research reported in the media". The third section of Part Three, Communication & Information Skills, grouped responses assessing if students are confident in communicating research and theories to a member of the general public and asking an intelligent question of an expert in the field. The student's response mean increased in all three sections and were statistically significant (see Figure 1).

Part Four, Food Systems & Choices in Figure 1, surveys students' understanding of food issues related to food systems, food choices, and sociological and biological relationships with food. Mean responses were significantly higher on the exit compared to the entrance survey. Upon grouping all survey items in Part Four, there was a significant increase in students' overall understanding of food issues by the end of the semester. Table 5 summarizes post-hoc analyses of individual survey items, which reveal statistically significant increases for each item in Part 4.

Table 5. Food System & Choices.

Survey item	P-value	Δ
How science & technology shape food production	<0.0001*	0.63
How government laws & policies impact food production & distribution	<0.0001*	0.59
How food production & consumption patterns affect social inequality	<0.0001*	0.50
How food production & consumption impacts the environment	0.0002*	0.39
How humans, plants, & animals are ecologically connected	<0.0001*	0.46
Where food comes from	<0.0001*	0.55
How food affects human health	<0.0001*	0.50
How the human body processes and uses nutrients	0.001*	0.42

C. Qualitative Results.

We were able to use qualitative data from the survey to develop a more substantive view of who our students are by analyzing entrance and exit responses to an open-ended question asking students to list three food issues that interested them. These findings are listed by thematic category and summarized in the Table 6 below.

Table 6. Responses to "Please list three food issues that interest you most," by thematic category, entrance and exit responses.

Thematic Category	Total Responses, Entrance	Total Responses, Exit	Totals
Food Production and Distribution, Laws and Policies	14	16	30
Food Production and Consumption, Social Inequality	22	15	37
Food Production and Consumption, the American Diet	125	131	256
Plants, Animals, Humans, Ecological Connections	11	14	25
Food and Human Health	105	87	192
All other responses	11	15	26
Totals[1]	288	278	566

Discrepancies between entrance and exit totals derive from double counting of some answers.

An examination of responses as coded by broad thematic categories show that student interest centers around two sets of themes, 1) Food Production and Consumption and 2) the American Diet and Food and Human Health. An examination of the subcategories in each of these thematic areas further illuminates where student interests lie. In the area of Food Production and Consumption and the American Diet, student responses that were most frequent included organic foods and methods and issues related to growing organic food; local food and how to increase its presence in consumer markets; sustainability and methods for creating sustainability; processed foods and their abundance in the American food system; corn's omnipresence in the American diet; GMOs; interests in learning to grow own food or in community gardens; concern about food in public schools and foods available to children; concerns about the meat industry and the preponderance of meat in the American diet. In the category of Food and Human Health, the most popular subcategories named by respondents included healthy food choices and preparation; how food works in the body; chronic disease and diet; and interest in vegan diets. (See tables 2.1 and 2.2 in Appendix 2 for the numerical distribution of these responses.) A striking feature of responses to our survey was that students' interests as a whole did not shift in a significant way between entrance and exit surveys. This suggests that the Food For Thought cluster supported or reinforced student interests rather than changed their interests. It also gives us important insights into the motivations of our students as learners.

We re-coded student response for indicators that students were particularly interested in bringing about change in a particular arena. Again, we find that the students who responded to our survey are fairly engaged in their interest to effect change (27% of all responses reflected an interest in change); examples of this include responses such as "government's role in the food industry and how it can be changed"; "helping those who do not have access to healthy food"; and "school lunch reform". (See Appendix 2, Table 2.3 for details.) The Food for Thought cluster appears to have some impact on student interest in this kind of engagement with food issues, again these issues are most concentrated in the area of changing the food production and consumption systems related to the American diet.

IV. Discussion.

A. Interpretation of key findings.

As a whole, the Food for Thought cluster had a positive impact on student learning. This is demonstrated by a statistically-significant positive change in nearly all categories of assessment questions in Figure 1. We attribute much of the positive changes in students' evaluation of their learning to the cluster projects and activities. For example, the questions in the Food Literacy section of the survey (see Part 3, Figure 1) addresses issues and problems tackled in the cluster projects and activities (such as the Harvest Bounty Shared Meal and the Poster Presentations), and are only covered as class content in a few cluster courses (see Nutrition and Lifestyle and Land Economics, Table 1). The survey responses are for all cluster students. Therefore, we interpret that Food Literacy, which had the largest mean change between entrance and exit survey response (0.52 increase on a 5-point Likert, see Figure 1), increased for all cluster students from learning in cross-course interactions.

Evidence of this interpretation is also seen in a marked increase between entrance and exit surveys in Understanding Food Systems (see Part 4, Figure 1). Table 2 reports changes in

mean survey responses for the questions about Understanding Food Systems. Again, some of these individual questions focused on class material in individual courses (e.g., "How government laws & policies impact food production & distribution" is part of how class material is presented in Food Politics and Nutrition Policy and Land Economics courses; and "How humans, plants, & animals are ecologically connected" is a focus of the Plants and Humans course). But, we measure a positive change in every question for the entire cluster because understanding food systems is essential to successfully complete and participate in all cluster projects and activities (see Table 2).

A third example of how cross-course projects and activities impact students is in their interest in Civic Engagement (see Part 2, Figure 1). Service Learning is incorporated into only one cluster course (see Nutrition and Lifestyle, Table 1), but survey responses show a 0.30 increase in Civic Engagement across the cluster. In addition to the quantitative analysis of attitudes toward civic engagement, we cull from the open-ended question at the end of our survey a code for student responses indicating an interest in change across all thematic categories. We find that in entrance and exit survey responses combined, 27% of all responses indicated an interest in engagement with change (social or educational); in addition, there was a 7% increase between entrance and exit surveys, suggesting some impact of the Food for Thought courses on students' interest in engagement as citizens that impact their communities.

Taken together, the quantitative and qualitative data suggest that an augmented sense of investment in civic engagement occurred in students during their participation in the Food for Thought cluster of courses. We interpret this increase because students are engaged with the campus and Asheville community as part of many of the cluster projects and activities. For example, a local or campus community member was a guest for each student group at the Harvest Bounty Shared Meal, Poster Presentations are created to be displayed at the North Asheville Tailgate market, and the Food and Nutrition Guidelines are written to change food policies on our campus.

In addition to impacting student evaluation of their learning course content in the areas of food, assessment results show increases in student growth as a general learner. For example, student perceptions increased 0.32 and 0.35 in areas of Research Literacy and Information & Communication Skills, respectively (see Part 3, Figure 1). Even though all of cross-course projects (see Table 2) require research literacy skills and involved communication and presentations to their class, to other classes and/or to community members, several of the cluster courses are upper level and/or for students in their major (see Table 4) and involve significant student research and class presentations. Therefore it is difficult to separate the increase in students' evaluation of their research and communication skills due to cluster projects from those learned in the individual courses. However, we believe that these skills are enhanced in the cluster experience because students are more engaged in learning through the topic of food and in participating in the cross-course projects.

We expect that some of our survey questions, such as those on Academic Attitudes (see Part 1, Figure 1), are not likely to change during a single semester. We include these items because we intend to track students from the beginning of their first cluster course to the end of their final (third) cluster course to determine whether attitudes change over the entire cluster experience. As a result, we did not expect significant changes in all of our survey items over the course of just one semester. This expectation is confirmed by the results in Figure 1; Academic Attitudes showed no statistically significant change.

Furthermore, there was no statistically significant change in questions focusing on assessing students as Informed Consumers (see Part 2, Figure 1). Even though topics addressing why specific food choices are made (questions asked in the grouping of Informed Consumer), the mean student response in the entrance survey already ranked this grouping as 4 ("highly") out of 5 on the Likert scale. Students who responded to the entrance and exit surveys entered their cluster course feeling as "highly" informed consumers. Therefore, we would not expect that course content and cluster projects and activities would make an additional impact.

B. Limitations.

There are several limitations to this study. Because participation in the entrance and exit surveys is voluntary per approved institutional review board protocol and we limit our data analysis to only those students who completed both surveys, we have an effective response rate of 20.7%. As a result, most students who completed cluster courses in the semesters studied were not included in our analysis. We have experimented with various methods for improving response rate, including providing class time to complete the survey, which may improve response rates in future studies.

A second limitation to the study is the use of Likert scale responses. In some items, we had entrance survey responses that were near the top of the scale (e.g., mean score 4 out of 5); as a result, it is more difficult to show statistically significant gains in the course of one semester. It may be that the students who had entrance responses at the lower end of the range did not complete the exit survey, thus biasing these results toward non-significant changes for those items. It is also possible that students who selected this cluster, were interested and somewhat knowledgeable on its topic *a priori*, and therefore began the semester with high scores on the entrance survey.

A third limitation is the short study duration of a single semester. Although statistically significant changes occurred on most survey items within one semester, the full pedagogical effects of the cluster courses would possibly be even more apparent with an analysis over three or more semesters. Our findings are further complicated by the fact that students may have taken more than one course in the cluster in a single semester or across the 3 semesters studied. Future studies will assess whether the cluster courses affect academic attitudes (Part 1) and food consumption choices (Part 2) over a longer period and whether the number of cluster courses a student participates in impacts the findings.

Another possible limitation is the lack of a control group for comparison with these results. Given the nature of the assessment and the project, it was not feasible at the time to construct a reasonable control. In the future, we hope to design a control by giving the survey to students in courses that previously were in the cluster or in courses that are in the cluster, but not currently engaged in the cluster activities for one or more reasons. Could the changes documented in this study be the result of taking a course in college that strikes a student's fancy? While we can't say for sure, we do know that in many areas related to our cluster outcomes, student perceptions of learning gains are significantly impacted by taking one of the Food for Thought cluster courses. In addition, we suggest that student perceptions of learning are enhanced through supporting and reinforcing student interest rather than somehow being wholly responsible for it.

C. Implications.

The benefits of using cross-course projects and activities for students engaged in courses that share a set of common learning outcomes around the theme of "becoming an informed consumer of food" are described by our findings. Students report that they are learning in these courses and due to the nature of the individual courses and the cross-course projects and activities it is possible to see that some of that learning is happening because of this interdisciplinary structure. In speaking about this course collaboration in conference settings and in interactions with our students, it has been made clear that there may also be some philosophical benefit to students as they try to make sense of interconnections between material in various courses required in their programs. The cluster model with clearly articulated shared learning outcomes and the experiential nature of the cross-course projects and activities offers students an opportunity to have an "aha" moment about the importance of a liberal arts education early in their career.

In addition, some less tangible benefits have been noted by the faculty involved. We see ourselves as a more engaged faculty who teach differently because of that engagement with each other, the students in the cluster and the material in our colleagues' courses. Course planning and materials development happen differently and more critically because of our collaboration. For some of us, our community connections have been strengthened. These collaborations have provided opportunities for community-based research and programming through the development and implementation of the food cluster projects. Cross-course projects and cluster activities provide opportunities for faculty to learn from each other and from the students in other courses as well as our own. Together we have engaged in faculty development opportunities to learn and also to share our experiences with other faculty. Also for some of us, it has been an introduction to participation in the scholarship of teaching and we have learned from our colleagues about the importance of doing this type of research.

Just as there are clear benefits to the cluster activities, there are also costs. One significant cost is faculty and student time. The Food Cluster faculty meets at least monthly to plan, manage and attend activities; evaluate assignments; and deal with logistical issues. In addition, students must use out of class time to meet with other cluster students to complete cross-course projects and to attend activities.

In addition, there is an opportunity cost in our individual courses. We work our individual syllabi around cluster projects and activities, modifying the course assignments and projects that we require of students to accommodate the time, energy and knowledge that students have gained from the cluster activities and projects. We often find ourselves spending time in class on cluster matters such as helping to coordinate student projects and answering logistical questions. This class time would have otherwise been spent on the course content or some other course activity. We sometimes coordinate course schedules to allow for groups to work on cluster activities leaving less time flexibility to accommodate other activities. And, when there are several courses working together on a cluster project, the process and outcomes are less predictable for students and faculty alike, which brings uncertainty.

There are financial costs associated with the Food for Thought cluster as well. While some activities require no money (Food and Dietary Guidelines project), others cost a few hundred dollars (farm tours, poster sessions). Our most expensive activity is the Harvest Bounty Shared Meal. We reimburse students for appropriate food costs; as a result, this activity costs about one thousand dollars each semester we offer it. We made the decision to avoid burdening students with the costs of cluster activities whenever possible; as a result, we have sought

internal and external funding to support our activities. In the three semesters analyzed here, we spent a total of $2600 from internal grants and donations from local restaurants. In previous semesters, we also received funding from our department budgets and dean. While this funding has allowed us to engage ourselves and our students in very meaningful ways, we could complete our cluster activities without any funding by restructuring activities, not reimbursing students for food costs, requiring students to drive themselves to activities, etc. Another option for covering activity costs that might work well on some campuses is a lab fee that could be charged to each student.

Realizing the value of this cross-course approach depends upon some situational factors. Our faculty team has benefited from an administration that is very supportive of our efforts. We receive financial support from our departments, dean, and campus grant opportunities. Most particularly, we benefit from administrative support in that the work of developing, implementing and assessing these cross-course projects has been seen positively in faculty evaluation. From our experience, however, we believe the minimum conditions for making this cross-course approach happen is an idea for a cross-course project or activity that will offer support for student learning outcomes and at least two teachers willing to work together to implement the idea.

For this team of faculty the mutual reinforcement of our passion for creative engaged teaching and the intangibles make participating in this collaborative interdisciplinary teaching and learning project worth it. For example, when a grumbling student's attitude about healthy eating or doing a team project is transformed after participating in the Harvest Bounty Shared Meal the value comes into focus. Other encouragement comes when a student's enthusiasm for growing food in plastic buckets on her porch is sparked by visiting a community garden and weeding a row of potatoes for the first time. When chemistry students present proximate analysis of minerals in foods served on campus to social science students, we are inspired by observing a fire starting in these students to make a difference to the campus food environment. Or finally, when a graduate starts a Slow Food chapter or sends passionate pleas to write congressional representatives to support changes in school lunch, the extra time and energy needed to make these projects happen *feels* worth it.

V. Conclusion.

The cross-course projects and activities described in this paper are strategies that offer opportunity for students to integrate learning from diverse fields and to develop as holistic thinkers. These strategies, in contrast with learning communities, are more loosely and flexibly structured and create less of a close-knit bond typical of learning communities. While there are disadvantages to the integrative strategies proposed here, there are also advantages: lower amounts of necessary coordination between faculty; integrative opportunities that occur over multiple semesters of a student's time in college; the involvement of students at different levels; the opportunity for more experienced students to mentor junior students; and project-based contexts for students in different disciplines to learn from one another. Our data suggest that these strategies have positive effects on students' perception of their learning, a finding that encourages us to continue developing curricula that provide and enhance opportunities for integration.

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Appendix 1. Questions from entrance and exit surveys.

Enter your Student ID Number. The Student ID Number is the first 9 digits on your UNCA ONE-CARD. Remember that this is a confidential survey: student ID numbers are used to track surveys only.

Check the CL9: Food for Thought courses you are taking **in Fall 2010**. If you are enrolled in more than one Food for Thought course this semester, select one course here. For questions in PART THREE that refer to "this course", answer with regard to the course you selected here.

- ○ BIOL 110 - Plants and Humans
- ○ HWP 225 - Nutrition and Lifestyle
- ○ HWP 325 - Chronic Conditions and Illness
- ○ SOC 280 - Sociology of Gender
- ○ SPAN 110/120 - Elementary Spanish I & II

PART ONE Academic Attitudes:
In the following questions, please use the following classifications of natural, social and health sciences: Natural Sciences include fields such as biology, chemistry and physics. Social Sciences include fields such as economics, sociology, and psychology. Health Sciences include fields such as medical and health and wellness fields.

I am interested in...

1 = Not at all interested
2 = A little interested
3 = Somewhat interested
4 = Highly interested
5 = Extremely interested
N/A = Not Applicable

	1	2	3	4	5	N/A
Taking more undergraduate or graduate classes in the natural	○	○	○	○	○	○

sciences						
Taking more undergraduate or graduate classes in the social sciences	○	○	○	○	○	○
Taking more undergraduate or graduate classes in the health sciences	○	○	○	○	○	○
Exploring a minor, major, or career in the natural sciences	○	○	○	○	○	○
Exploring a minor, major, or career in the social sciences	○	○	○	○	○	○
Exploring a minor, major, or career in the health sciences	○	○	○	○	○	○
Completing a minor or major in the natural sciences	○	○	○	○	○	○
Completing a minor or major in the social sciences	○	○	○	○	○	○
Completing a minor or major in the health sciences	○	○	○	○	○	○
Learning in disciplines outside my major or intended major	○	○	○	○	○	○
Developing as an interdisciplinary thinker	○	○	○	○	○	○
Participating in interdisciplinary projects and activities	○	○	○	○	○	○
Working in a career with people from other disciplines	○	○	○	○	○	○
Volunteering or working for a non-profit organization focusing on food, health, farming, or environmental issues	○	○	○	○	○	○

PART TWO Civic Engagement and the Informed Consumer:

I care about...

1 = Not at all
2 = A little
3 = Somewhat
4 = Highly
5 = Extremely
N/A = Not Applicable

	1	2	3	4	5	N/A
Making food choices that are sustainable for the environment	○	○	○	○	○	○
Making food choices that are healthy	○	○	○	○	○	○
Making food choices that emphasize local food sources	○	○	○	○	○	○
Making food choices that are organic	○	○	○	○	○	○
Experimenting with new food choices or preparations (e.g., world cuisines, unfamiliar vegetables)	○	○	○	○	○	○
Making food choices that emphasize less processing	○	○	○	○	○	○
Participating in collective actions to change food policies at the local, national or global level	○	○	○	○	○	○
Helping others become more informed about their own food choices	○	○	○	○	○	○
Volunteering for a non-profit working with food, health, farming or environmental issues	○	○	○	○	○	○
Learning more about growing food Learning more about preparing food Learning more about the food I buy	○	○	○	○	○	○

PART THREE Interdisciplinary and Disciplinary Skills (Including Communication):

A) Food Literacy

I am confident I can...
1 = Not confident
2 = A little confident
3 = Somewhat confident
4 = Highly confident
5 = Extremely confident
N/A = Not Applicable

	1	2	3	4	5	N/A
Read and interpret a nutrition facts label on foods	○	○	○	○	○	○
Distinguish between food ingredients that are healthy and less healthy	○	○	○	○	○	○
Understand labeling on food packaging	○	○	○	○	○	○
Understand the nutritional benefits of the foods I eat	○	○	○	○	○	○
Evaluate the trade-offs involved in purchasing organic, local, unprocessed, or fair-trade foods	○	○	○	○	○	○

B) Research Literacy

I am confident I can...
1 = Not confident
2 = A little confident
3 = Somewhat confident
4 = Highly confident
5 = Extremely confident
N/A = Not Applicable

	1	2	3	4	5	N/A
Understand how natural scientists plan and conduct research	○	○	○	○	○	○
Understand how social scientists plan and conduct research	○	○	○	○	○	○
Understand how health scientists plan and conduct research	○	○	○	○	○	○
Evaluate the merits of research reported in the media	○	○	○	○	○	○
Understand how the material in this course is linked to the material in other Food for Thought Cluster courses	○	○	○	○	○	○

C) Information and Communication Skills

I am confident I can...
1 = Not confident
2 = A little confident
3 = Somewhat confident
4 = Highly confident
5 = Extremely confident
N/A = Not Applicable

	1	2	3	4	5	N/A
Communicate research and theories from this course to a member of the general public	○	○	○	○	○	○
Ask an intelligent question of an expert in the field of this course	○	○	○	○	○	○
Participate in a successful team project with my peers	○	○	○	○	○	○
Work with students in other courses to present research findings to the general public	○	○	○	○	○	○
Be an effective project team member	○	○	○	○	○	○
Work with people who have different perspectives or skills than I have	○	○	○	○	○	○
Articulate ideas relevant to this course in written form	○	○	○	○	○	○

PART FOUR Understanding of Food, Food Systems, Food Choices, Social Relationships and Biological Relationships

Presently, I have a good understanding of...

1 = Strongly Disagree
2 = Disagree
3 = Somewhat Disagree and Somewhat Agree
4 = Agree
5 = Strongly Agree
N/A = Not Applicable

	1	2	3	4	5	N/A
How science and technology shape food production	○	○	○	○	○	○
How government laws and policies impact food production and distribution	○	○	○	○	○	○
How food production and consumption patterns affect social inequality	○	○	○	○	○	○
How food production and consumption impacts the environment	○	○	○	○	○	○
How humans, plants and animals are ecologically connected	○	○	○	○	○	○
Where food comes from	○	○	○	○	○	○
How food affects human health	○	○	○	○	○	○
How the human body processes and uses nutrients	○	○	○	○	○	○

PART FIVE

Please list three food issues that interest you most:
Issue 1:
Issue 2:
Issue 3

PART SIX Demographic Information

What is your gender?

What is your age group (in years)?

- O 18 or younger
- O 19-21
- O 22-30
- O 31-40
- O 41-49
- O over 50

What best characterizes you discipline-based major in college (check all that apply if you are doing or considering a double major).

- O Natural Sciences and Mathematics majors (e.g., biology, chemistry, engineering, computer sciences)
- O Social Sciences majors (e.g., business, sociology, economics, education, psychology, mass. com.)
- O Health Sciences majors (e.g., pre-med, health and wellness)
- O Humanities majors (e.g., history, foreign languages, literature, multimedia arts & sciences, and interdisciplinary studies)
- O Undecided at this time

What is your level in college?

- O Freshman
- O Sophomore
- O Junior
- O Senior
- O Post-graduate
- O Not a degree seeking student at this time

Are you in a teacher preparation program?

- O Yes
- O No
- O Undecided at this time

What is your current GPA in a system that assumes a 4.00 is an A (highest score possible)?

- O 4.00-3.60
- O 3.01-3.59
- O 2.51-3.00
- O 2.01-2.50
- O 2.0 or lower

Appendix 2. Additional Tables from Open-ended questions.

Table 2.1. Food Production and Consumption, the American Diet, selected subcategories.

	Total Responses, Entrance	Total Responses, Exit	Totals
Local Food	18	27	45
Organic food/methods of farming or cultivating	24	18	42
Sustainability/methods of	9	12	21
Processed Foods	7	10	17
Gardening/growing own food/community gardens	8	7	15
GMOs	4	9	13
Proportion of corn/ corn syrup in US Food/corn industry/fructose	8	4	12
Food in Public Schools/children	5	5	10
Proportion of meat in American production/ Meat industry	6	1	7
All other categories combined	36	38	74
Totals	125	131	256

Table 2.2. Food and Human Health, selected subcategories.

	Total Responses, Entrance	Total Responses, Exit	Totals
Healthy Food options/ Healthy Eating/ Balanced Diets/ Healthy Preparation of Food	23	19	42
How body processes nutrients/food (F2 + F6)	9	10	19
Chronic disease and diet	7	7	14
Vegan Diets	6	5	11
Other categories combined	60	46	80
Totals	105	87	160

Table 2.3. Student interest in change.

Interest in social change in the area of…	Entrance	Exit	Totals
Food Production and Distribution, Laws and Policies	2	2	4
Protection of farmland		2	2
Food Production and Consumption, Social Inequality	1	3	4
Food Production and Consumption, Environment, The American Diet	5	5	10
Combined responses from categories: Interest in Organic foods, Local foods, Sustainability, Helping the Environment, Growing own food or community gardening,	59	65	124
Plants, Animals, Humans, Ecological Connections	1	3	4
Food and Human Health	1	1	2
General Interest in impacting change	1	6	7
Totals	70 (288 responses, or 24%)	87 (278 responses, or 31%)	157 (566 responses, or 27%)

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