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Implementing Selected Teaching Strategies to Accommodate Different Learning Styles among Students Enrolled in an Introductory Food Science and Human Nutrition course[1]

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Abstract

We conducted an exploratory, qualitative study of the impact of selected teaching strategies implemented in Introduction Food Science and Human Nutrition, a course with an enrollment of 208 undergraduate students. To complement a traditional classroom lecture, we integrated into the course a comprehensive, media-enhanced Web site; daily writing assignments; a peer-reviewed, a popular press publication critique; and product and process demonstrations. We used the Gregorc Style Delineator™ to determine the dominant learning style of each student. The distribution of Gregorc learning styles in our course was 42% Concrete Sequential, 14% Abstract Sequential, 26% Abstract Random, and 18% Concrete Random.

Following each of the four mid-term exams, the students completed a feedback form to help us assess the effectiveness of each teaching strategy on their learning styles. We analyzed the data using one-way ANOVA and the results indicate that selected teaching strategies can enhance learning among a group of students representing all four Gregorc learning styles. Our results suggest that instructors who recognize students exhibit different learning styles may be better prepared to modify their pedagogical repertoire (instructional activities, methods, and content) to fulfill the learning needs and preferences of their class.

Introduction

Learning occurs when an individual perceives, processes, and retains information using his or her sensory and perceptual skills. The method or style in which information is processed differs among students. A learning style is an individual's preferred method of perceiving, interpreting, processing, organizing, storing, and retaining new and complex information (Dunn and Dunn, 1987; Davis, 1993). A student's learning style may affect how he or she learns in specific instructional situations and environments (Hartel, 1995).

Educational researchers have proposed several learning style models and designed instruments to assess those styles. Six models are commonly cited in the literature: 1) Witkin's Field-Dependence/Independence model (Witkin et al., 1971); 2) Gregorc's Learning Style Delineator (Gregorc, 1982, 1985); 3) Kolb's Learning Style model (Kolb, 1984, 1985); 4) Felder-Silverman Learning Style model (Felder and Silverman, 1988); 5) Herrmann Brain Dominance model (Herrmann, 1990); and 6) Myers-Briggs Type Indicator (Lawrence, 1994). We selected the Gregorc Learning Style Delineator™ (GSD; Gregorc Associates, Inc., Columbia, CT) based on Anthony F. Gregorc's extensive research on a number of adolescent and adult learners in a variety of learning environments. The participants in our exploratory study collectively represent a large (n = 208), diverse group of college students from 42 different academic disciplines and educational experiences (Figure 1).

Gregorc (1979) asserted that learning styles evolve from two types of *learning* orientations (concrete and abstract) and two types of *ordering* orientations (sequential and random). By observing students, Gregorc determined that these orientations formed four distinct learning methods or styles: Concrete Sequential (CS), Abstract

[1] Adapted from the poster, "Accomodating different learning styles using a variety of teaching strategies in an introductory Food Science and Human Nutrition course" presented by author Javenkoski at the Annual Meeting of the Institute of Food Technologists, Chicago, IL 26 July 1999.

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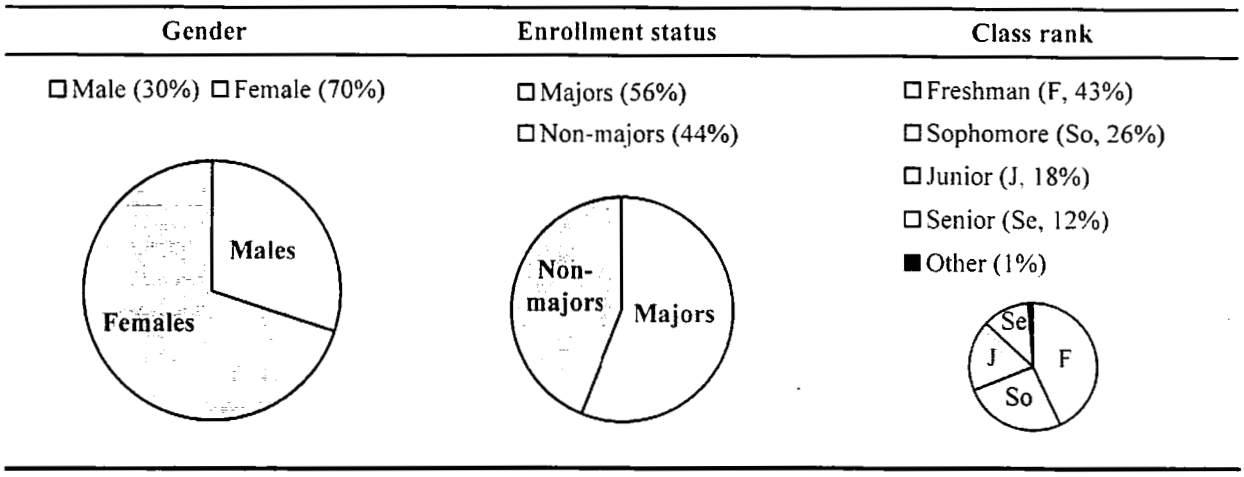

Figure 1. Demographic data for undergraduate students (n = 208) enrolled in FSHN 101 during the Fall 1998 semester.

Sequential (AS), Abstract Random (AR), and Concrete Random (CR) (Table 1). Although Gregorc claims some individuals use all four learning styles, most people exhibit a preference for one or two styles (Gregorc, 1979).

To enhance student learning, teachers should incorporate a variety of instructional strategies and tools into their classrooms to accommodate the different learning styles exhibited by their students. Felder and Silverman (1988) proposed 13 classroom strategies that can help instructors teach to all types of learners. Due to similarity, we condensed the list into 11 strategies and grouped them into two categories. Strategies 1–6 describe what instructors can do to enhance their *presentation* of information to students and strategies 7–11 describe what instructors can do to improve the *perception* of the information by students.

According to Felder and Silverman (1988), teachers can enhance the *presentation* of information to students by: 1) explicitly stating the connections between past, present, and future course material and connections between the course material (theory) and the student's practical, applied experiences; 2) balancing concrete information (facts, data, experimental results) with abstract concepts (principles, theories, models); 3) balancing practical problem-solving methods with dialogue to reinforce understanding of fundamental topics; 4) reinforcing (through illustration) intuitive patterns in the information presented; 5) integrating visual/sensual representations (images, graphs, demonstrations) into oral and written explanations, and 6) integrating networked computer technology to deliver instruction both synchronously and asynchronously to students.

The *perception* of information by students can be enhanced by: 7) providing students with adequate time to comprehend and respond to the lecture material (for example, writing their written responses to questions and then pair-sharing with peers); 8) providing students with adequate time for active participation (like brainstorming) and for low to higher-order cognitive activities (for example, practicing calculations during problem-solving activities); 9) facilitating collaborative learning activities (such as group research assignments and in-class presentations); 10) acknowledging and rewarding students' participation and creativity; and 11) discussing the concept of learning styles with your class.

Gregorc and Ward (1977) correlated various forms of instructional media (for example, textbooks, movies, television, and programmed instruction) and instructional delivery preferences (lectures, group work, and independent study) with each learning style type (Figure 2). In our study, we investigated the relationship between the instructor's presentation of the content and our student's perception of it for each of the four Gregorc learning styles.

Table 1. Descriptions of the four Gregorc learning styles and the distinguishing adjective for students exhibiting that learning style (adapted from Gregorc, 1979; Taylor, 1997; and D'Arcy, C.J., personal communication).

Learning style	Description of learners
Concrete Sequential (CS)	Learners prefer direct, hands-on experience. They like concrete examples, actual experiences, and teaching techniques that present information in an orderly sequence of connected parts: for example, they prefer topic outlines to concept maps. They prefer directions from instructors and a clearly defined teacher/student relationship. They exhibit extraordinary development of one or more of the five senses. They see situations as "black and white" or "right and wrong," and want to know the "best" or "correct" way. They apply literal meaning to verbal and written communication. They are able to approach tasks consisting of discrete parts without knowing the "big picture," delay gratification until the job is complete, follow step-by-step directions, and are attentive to details. They are organized, habitual, punctual, and desire perfection. They are the "doers." They display a low tolerance for distractions. Key adjective: practical.
Abstract Sequential (AS)	Learners prefer to deal with abstractions and avoid direct, concrete experiences in favor of simulated experiences: for example, they tend to prefer lectures to labs. They prefer techniques and activities featuring substance, structure, and sequence. They are especially adept at seeing models and the "big picture." They have excellent abilities with written, verbal, and image symbols. They like to read, listen, and use their visual skills. They expect their teachers to demonstrate expertise and authority in the classroom and to provide documentation for the ideas they present. They demonstrate good analytical and evaluative abilities. They follow guidelines reasonably well, but have little acceptance of nebulous directions. They display a low tolerance for distractions. Key adjective: probable.
Abstract Random (AR)	Learners have a capacity to sense feelings and emotions, and use their intuition to their advantage. They prefer experiences that are subjective, affective, and abstract. They like learning options as opposed to a single, fixed approach to instruction. They prefer learning in an unstructured environment, such as group discussions and activities. They prefer guidance from teachers. They are highly empathetic, can easily see the "gray," and see the "whole" but not the parts. They apply subjective analysis to verbal and written communication and need time to reflect and assimilate new or difficult information. They are internally motivated, expect they will perform well, and look for subjective signals of approval and disapproval. They may ignore directions and not meet deadlines. They display a reasonably high tolerance for distractions. Key adjective: potential.
Concrete Random (CR)	Learners prefer concrete applications of ideas through examples and practice. They like to learn independently or in small groups using trial-and-error experiments; for example, they tend to prefer labs to lectures. They prefer instructional options, alternative approaches, teachers who serve as both instructors and guides. They demonstrate insight in multiple situations and can make intuitive leaps that result in creative alternative solutions to problems. They have an extraordinary ability to form relationships. They simultaneously respond to both internal and external rewards. They are problem-solvers and are application oriented; they like change and new experiences. They dislike systematic procedures and often start a new project without reading the directions. They have creative ideas, but are not the "doers." They prefer a stimulus-rich environment and can concentrate well despite a moderate amount of distraction. Key adjective: possible.

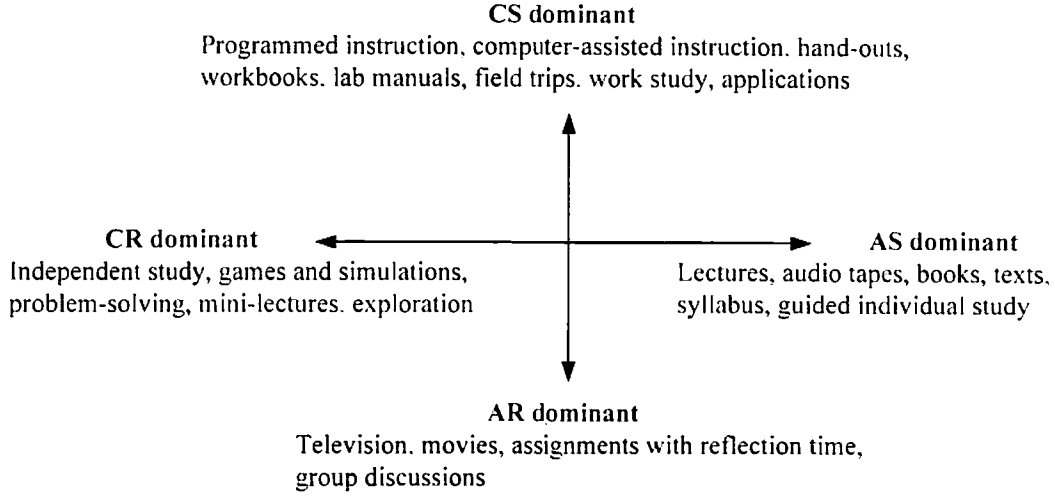

Figure 2. Instructional media and instructional delivery preferences that correspond with each of the four dominant Gregorc learning styles (Gregorc, 1982).

Objectives

The research objectives of this qualitative study were to: 1) use the GSD to identify the dominant learning styles of undergraduate students in an introductory Food Science and Human Nutrition (FSHN) course; and 2) assess the impact of integrating selected teaching strategies in a Food Science and Human Nutrition course comprised of students who collectively exhibit different learning styles.

Methods

The GSD (Gregorc, 1982, 1985) was administered during the second lecture of the Fall 1998 semester to the instructor and 208 undergraduate students enrolled in FSHN 101: Introduction to Food Science and Human Nutrition. The associate director of the Office of Instructional Resources at the University of Illinois at Urbana-Champaign (UIUC) supervised the GSD assessment. The students received a 20-minute presentation that defined learning styles, described learning style assessment, and outlined the qualitative research that we would conduct during the semester. At the conclusion of the presentation, the students completed the GSD instrument and we recorded their individual scores for each of the four GSD learning styles (CS, AS, AR, and CR).

According to Gregorc (1982, 1985), a GSD score ranging from 10–15 points in any of the four learning styles indicates it is a "low" (non-preferred) learning style. A score ranging from 16–26 points is an "intermediate" (preferred) learning style, and a score ranging from 27–40 points is a "dominant" (highly preferred) learning style. To achieve our first research objective, we constructed a frequency distribution (or "GSD profile") for the FSHN 101 class. We grouped the students according to their highest learning style score, indicated by the learning style type with highest point total on the GSD instrument. In the case of a tie (two of the four learning styles had equal point value for an individual), we distributed one-half of the case to each of the two learning style categories. We then determined the GSD profile (Equation 1) by calculating the percentage of each learning style represented by the class enrollment.

During the Fall 1998 semester, we selected and implemented several teaching strategies from Felder and Silverman's (1988) list to accommodate the different learning styles exhibited by the undergraduate students enrolled in the FSHN 101 course. The first strategy integrates networked computer technology into our class via a courseware application called the Virtual Classroom Interface (VCI) (Schmidt and Javenkoski, 1996). VCI, developed at UIUC in 1996, enables instructors to construct and maintain a Web site comprised of nine modules of course content. Using a Web browser, students have time- and location- independent access to these modules: Syllabus, Lectures, Assignments, Announcements, Review Files (sample exam questions),

$$\text{GSD profile} = \frac{\text{Total number of students exhibiting each learning style}}{\text{Total number of students who completed the GSD}} \times 100$$

Equation 1. The "GSD profile" of learning styles exhibited by our sample (n = 208) of undergraduate students enrolled in the FSHN 101 course. Using this equation, we determined that the most common, dominant style was Concrete Sequential {[(86.5/208)] x 100 = ~42%} and the least common, dominant style was Concrete Random {[(38/208)] x 100 = ~18%}.

Chat Space (an message board where students can exchange information with the instructors and other students), a Hot List (links to other food and nutrition related sites), WWW Resources (links to other UIUC sites), and VCI Help, which provides guidance for using the courseware.

The FSHN 101 lecture outlines contain both discrete (text, images, and graphs) and continuous (audio, video, and molecular animations) media for many of the course topics. Students download the outline files to a printer and bring to class printed copies on which they annotate additional notes and examples discussed during lectures. Consequently, students can spend more time listening to and comprehending the material, rather than hurriedly transcribing the lecture content. Our second, related strategy uses transparency projections adapted from the VCI lecture outlines and the course reading packet during the classroom lectures. The transparencies enable the instructor to write additional details about the topics as well as examples and questions volunteered by the students. The students benefit from seeing a structured textual summary that complements the verbal description delivered by the instructor.Our third instructional strategy uses daily, in-class writing assignments called "Microthemes." During each lecture, students must write brief responses to brainstorm topics based on the lesson, pertinent news stories, or problem-solving calculations chosen by the instructor (Figure 3). Following the 5-minute writing exercise, the instructor identifies a consensus opinion or answer based on volunteered student responses. In a semester, we assign 37 Microthemes (5 points each), comprising 20% of the total available points in the course.

Our fourth strategy assigns one out-of-class writing exercise called the "Popular Press Critique." Students critically evaluate the pervasive influence of the mass media on the public and the validity of scientific information in popular press reports on food and nutrition issues. To complete the assignment, students read two publications ("Confessions of a former women's magazine writer" [Larkin, 1993] and "Food News Blues" [Schmitz, 1991]) and complete worksheets for assessing the content presented in those articles. Then the students exchange a draft of their critique with a classmate and complete a peer evaluation using a pre-designed form. Once the students integrate the written feedback from their peers, they submit a final draft of their paper (150 points, 16% of the total available points in the course). Students may ask the instructor to review a draft of their critique following revisions from the feedback they received during the peer evaluation process. In the Fall 1998 semester, only 15 out of 208 (~7%) submitted a draft for instructor review prior to completing the Popular Press Critique.

Our fifth instructional strategy employs in-class samples and examples. The instructor describes and shares a variety of food ingredient and product samples to illustrate and reinforce course concepts. For example, during one of the food processing lectures, we describe heat transfer mechanisms applied in thermal processing of three canned foods (chicken broth, peaches packed in heavy syrup, and corned beef hash). From the presentation and discussion, the students apply their knowledge to select and justify which products require the lowest and highest thermal treatment to assure commercial sterility in the containers.

Our sixth strategy provides students with several choices for communicating with the instructor and other classmates. Students are encouraged to meet with the instructor in the classroom (before and after lecture), during scheduled office hours or by appointment, via e-mail, and in the VCI Chat Space. We also offer point incentives for communication among classmates by rewarding them for participating in peer reviews for the Popular Press Critique and attending VCI training and exam review sessions.

To assess the effectiveness of each teaching strategy on our students' perceptions of the information presented in the lecture, we captured written feedback throughout the semester. Following each of four hourly, mid-term exams (100 points each), the students completed a feedback form designed to assess the impact of each teaching strategy on their learning style. A different

Figure 3. During each lecture, students use a Microtheme card on which they write brief responses to a topical theme or problem-solving calculation chosen by the instructor.

Feedback Form was distributed with each hour exam (Forms A–D). The captured data were filtered by excluding feedback from students whose GSD learning style score was less than 32 and/or failed to complete and submit all four Feedback Forms. We chose the criterion score of 32 because we believed it was sufficiently high enough to ensure that only students with one dominant learning style were included in each category. This process reduced our sample size from 208 students to 70. In the case where a student scored greater than or equal to 32 in more than one learning style, we used the highest score to identify the dominant learning style. In the case of a tie score between two styles, we randomly assigned the student to one of their two dominant style groups.

We analyzed each item on the feedback forms using a one-way analysis of variance (ANOVA) F-test with an α - level of 0.05. If a student reported no experience (NE), did not respond to an item, or used a value outside of the assigned scoring range of 1–10 (for example, 0), then we omitted their response from the analysis for that item. We did not analyze the "level of comfort of understanding" items included on Feedback Forms A (Item 11) and B (Item 5) and the open-ended items on Feedback Form C (Items 5–7) because the responses were not pertinent to this study.

Previous research (Garton et al., 1998) suggests that learning style influences the academic achievement of students. To test this assertion, we also analyzed the students' course grades using an ANOVA F-test with an a - level of 0.05. Historically, FSHN 101 students with cumulative course scores of 90% or higher are excused from the final exam. Consequently, we analyzed the course grades without the final exam points. The total points available in the course without the final exam is 735.

Results and Discussion

Class Demographics

We obtained class demographic data (Figure 1) from the enrollment database available to the instructor through the campus online course registration application, U of I Direct.

Instructor and Student Learning Styles

The dominant learning style of the FSHN 101 instructor (author Schmidt) is CS (comprised of the following learning style scores captured with the GSD: CS = 33; AS = 28; AR = 24; CR = 15). Using the GSD results from the entire class (n=208), we calculated sum scores for each Gregorc learning style, which indicated that the most common, dominant style was Concrete Sequential and the least common, dominant style was Abstract Sequential (CS = 86.5; AR = 54; CR = 38; and AS = 29.5). The proportions of dominant learning styles (also classified by gender) among the students are displayed in Figure 4. The percentage of males and females within both the CS and CR learning styles is similar to the overall gender distribution of the class (Figure 1). In the AS learning style category there are more males than females and in the AR learning style there are more females than males compared to the overall gender distribution of the class (Figure 4).

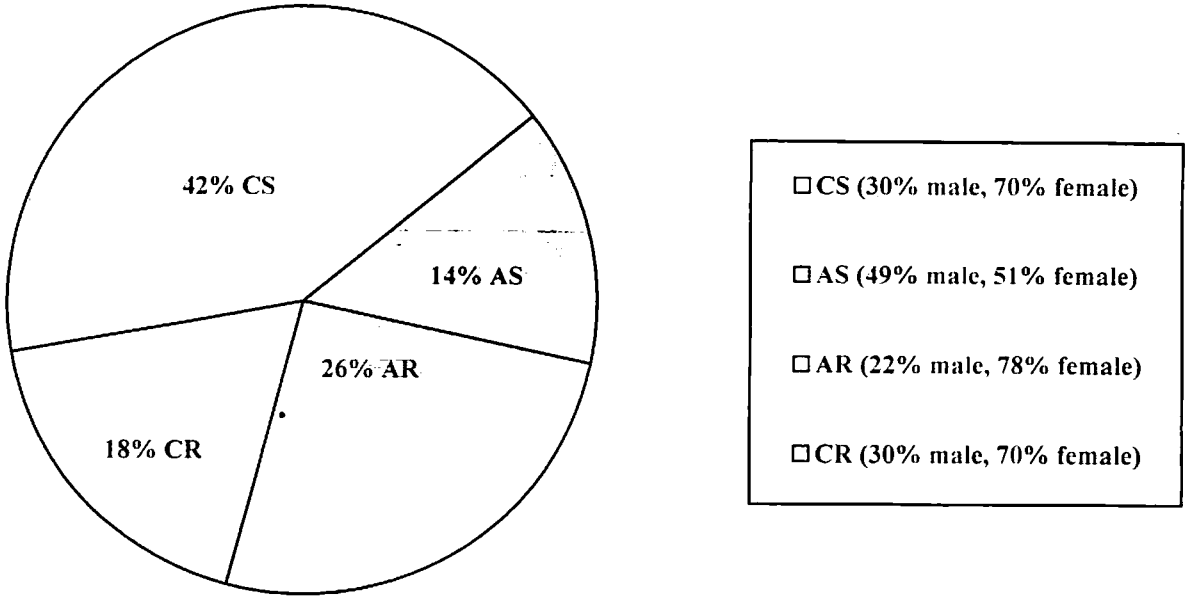

Figure 4. The distribution of learning styles for the FSHN 101 Fall 1998 class (n = 208), including percentage by gender within each learning style group.

Food Science and Human Nutrition 101, Fall 1998; Early Feedback Form A

This survey is designed to provide Professor Schmidt with feedback on the effectiveness of the course activities as they correspond to your personal learning style. Rate the overall effectiveness of the following activities on your learning of the course material. Please answer the first 10 items by writing the number which best describes your feelings on a 10-point scale for each item, where 10 is very effective and 1 is not very effective. If you have had no experience with an item please mark NE. Note Item 11 uses a different rating scale and Item 12 asks for any additional comments you may have. Don't forget to print your name at the bottom of the page.

Item — Scale: 10 very effective to 1 not very effective or NE

1. Overall use of the Virtual Classroom Interface (VCI) _____

2. Specific VCI features:

a. Access to course information (e.g., syllabus, review files) _____

b. Lecture notes

1. Availability _____

2. Organization _____

c. QuickTime™ videos _____

d. Lecture audio summaries _____

e. Links to other Web sites _____

3. Classroom lectures _____

4. Examples and samples used during class _____

5. Daily Microthemes:

a. The assignment itself _____

b. Discussion time _____

6. Popular Press Critique _____

7. FSHN 101 Reader _____

8. Office hours/office visits _____

9. E-mail correspondence _____

10. Review sessions _____

11. Rate your level of comfort of understanding of each of the following concepts:

Scale: high/moderately high/medium/low/none at all

a. Nutrient and energy RDAs _____

b. Calorie content calculations _____

c. Effects of the Dietary Supplement Health and Education Act (DSHEA) of 1994 on the food industry _____

12. Additional comments?

Your name (please print) _____ THANK YOU!

Table 2. Results of one-way ANOVA F-tests on survey data captured with Early Feedback Form A. The middle four columns display statistics for students grouped by their dominant Gregorc learning style category (Concrete Sequential = CS, Abstract Sequential = AS, Abstract Random = AR, and Concrete Random = CR)

Item	CS (n = 12)	AS (n = 9)	AR (n = 20)	CR (n = 9)	P-value
1	8.4 ± 1.74 [a]	8.2 ± 1.30 [a]	8.6 ± 1.98 [a]	9.1 ± 1.05 [a]	0.67
2a	9.3 ± 1.23	8.9 ± 0.93	9.1 ± 1.25	9.4 ± 1.33	0.69
2b1	9.4 ± 1.16	9.0 ± 1.66	9.6 ± 0.60	9.4 ± 1.01	0.60
2b2	9.6 ± 0.61	9.0 ± 1.12	9.3 ± 0.92	9.3 ± 0.87	0.18
2c	6.3 ± 2.61	6.6 ± 0.92	5.8 ± 3.06	5.7 ± 2.40	0.82
2d	7.8 ± 2.12 [a]	5.5 ± 3.45 [b]	6.4 ± 2.80 [a,b]	8.3 ± 1.32 [a]	0.05* [c]
2e	7.4 ± 2.62	5.3 ± 4.51	7.2 ± 2.92	8.3 ± 1.89	0.48
3	8.8 ± 1.15	8.8 ± 1.64	8.4 ± 1.57	9.6 ± 0.53	0.15
4	8.7 ± 1.26	8.7 ± 1.50	8.21 ± 1.65	9.3 ± 0.87	0.26
5a	8.4 ± 1.66	7.7 ± 1.80	8.2 ± 1.50	7.8 ± 2.28	0.61
5b	8.4 ± 1.46	7.9 ± 1.76	8.5 ± 1.61	8.2 ± 2.59	0.83
6 [b]					
7	7.7 ± 2.02	7.6 ± 1.87	7.3 ± 2.37	7.4 ± 1.81	0.94
8	8.9 ± 1.44	7.5 ± 0.00	7.3 ± 2.69	8.8 ± 1.17	0.25
9	7.9 ± 2.64	8.7 ± 1.77	7.1 ± 3.18	9.5 ± 1.00	0.49
10	7.7 ± 2.40	8.2 ± 1.61	7.9 ± 2.45	7.6 ± 3.36	0.99

[a] Values displayed are the sample (n) average ± standard deviation.

[c] Significant difference at the α = 0.05 confidence level. Mean separation in row determined by Fisher's LSD.

[b] At the time this feedback form was distributed, the students had not started the Popular Press Critique assignment. Consequently, we omitted Item 6 from the analysis. We reiterated the Popular Press Critique item on Form B, Item 4.

Food Science and Human Nutrition 101, Fall 1998: Early Feedback Form B

As you are aware, your final grade in FSHN 101 is determined by a combination of exams and assignments: 4 hour exams (100 points each), 1 final exam (200 points), a Popular Press Critique (150 points; 50 points for the peer review and 100 points for the final paper), and the daily Microtheme assignments (185 points). This evaluation form is designed to provide Professor Schmidt with feedback about how you like the various types of performance measures used in this course. Your responses will be assessed based on to your personal learning style. Please rate the degree to which you like the following types of performance measures on a 10-point scale, where 10 is like very much and 1 is dislike very much. Note Item 5 asks you to rate your level of comfort of understanding of three concepts presented in the Food Composition and Chemistry section of the course. In addition, Item 5 uses a different rating scale from high understanding to none at all. Item 6 asks for any additional comments you may have. Don't forget to print your name at the bottom of the page.

Item — Scale: 10 like very much to 1 dislike very much

1. Hour exams:
   - a. Exams overall _____
   - b. Multiple-choice _____
   - c. True-false _____
2. Final exams _____
3. Daily Microtheme assignment _____
4. Popular Press Critique:
   - a. Peer review aspect _____
   - b. Paper aspect _____
5. Rate your level of comfort of understanding of each of the following concepts:

   Scale: high/moderately high/medium/low/none at all

   - a. Delta and omega nomenclature used for naming fatty acids _____
   - b. Significance of the 1958 Food Additive Amendment to the food industry, U.S. government, and the consumer _____
   - c. Physical and chemical reactions which occur during the making of a wheat flour dough _____
6. Additional comments?

Your name (please print) _____ THANK YOU!

Table 3. Results of one-way ANOVA F-tests on survey data captured with Early Feedback Form B. The middle four columns display statistics for students grouped by their dominant Gregorc learning style category (Concrete Sequential = CS, Abstract Sequential = AS, Abstract Random = AR, and Concrete Random = CR).

Item	CS (n = 32)	AS (n = 9)	AR (n = 20)	CR (n = 9)	P-value
1a	6.9 ± 2.01 [a]	6.9 ± 1.90 [a]	6.1 ± 2.09 [a]	7.0 ± 2.40 [a]	0.49
1b	8.1 ± 1.72	8.0 ± 1.23	7.0 ± 2.11	8.6 ± 1.24	0.08
1c	4.8 ± 2.75	4.7 ± 2.50	4.8 ± 2.66	5.0 ± 2.96	0.99
2	3.9 ± 2.90	4.7 ± 3.04	4.5 ± 2.51	4.4 ± 2.97	0.87
3	7.9 ± 2.41	7.7 ± 2.00	8.4 ± 2.35	7.4 ± 2.88	0.71
4a	8.0 ± 2.06	6.9 ± 1.69	7.7 ± 2.54	8.7 ± 1.73	0.33
4b	7.7 ± 1.92	7.1 ± 1.36	7.2 ± 2.65	9.1 ± 1.05	0.11

[a] Values displayed are the sample (n) average ± standard deviation

Food Science and Human Nutrition 101, Fall 1998: Early Feedback Form C

Since the "technology tools" are up and running (at least some of the time in 180 Bevier Hall), we have been able to watch the QuickTime videos incorporated into the FSHN 101 VCI site during class. On early feedback form A (distributed after exam 1) the feedback I received regarding the QuickTime videos was based only on being able to view the media outside of class. This evaluation form was designed to provide Professor Schmidt with feedback about the learning value of the videos if they are viewed during lecture as opposed to out of class. Please answer the first 4 items by writing the number which best describes your feelings on a 10-point scale for each item, where 10 is very effective and 1 is not very effective. Note Items 5, 6 and 7 ask you opened ended questions regarding the QuickTime videos. Item 8 asks for any additional comments you may have.

Don't forget to print your name at the bottom of the page.

Item — Scale: 10 very effective to 1 not very effective

1. In general, viewing the QuickTime™ videos (during class) helps me to better understand the course material. _____

2. In general, viewing the QuickTime videos (during class) helps me to better learn the course material. _____

3. The question posed at the beginning of each QuickTime™ video helps me to better manage the information I am required to know from the video for the exams. _____

4. Overall, the QuickTime videos when viewed during class are effective learning tools. _____

5. I like the QuickTime videos because: _____

6. I dislike the QuickTime videos because: _____

7. Do you have any suggestions to improve the QuickTime videos or their use during class? _____

8. Additional comments?

Your name (please print) _____ THANK YOU!

Table 4. Results of one-way ANOVA F-tests on survey data captured with Early Feedback Form C. The middle four columns display statistics for students grouped by their dominant Gregorc learning style category (Concrete Sequential = CS, Abstract Sequential = AS, Abstract Random = AR, and Concrete Random = CR)

Item	CS (n = 32)	AS (n = 9)	AR (n = 20)	CR (n = 9)	P-value
1	8.0 ± 1.97	7.9 ± 1.62	8.2 ± 1.65	8.1 ± 1.62	0.94
2	7.7 ± 1.8	7.4 ± 1.74	7.8 ± 2.12	7.7 ± 1.50	0.97
3	9.0 ± 1.63	9.2 ± 1.09	8.8 ± 1.18	9.2 ± 0.97	0.23
4	8.3 ± 1.85	7.9 ± 1.63	8.6 ± 1.27	8.6 ± 1.01	0.73

[z] Values displayed are the sample (n) average ± standard deviation.

Food Science and Human Nutrition 101, Fall 1998: Early Feedback Form D

This evaluation form is designed to provide Professor Schmidt with feedback on the effectiveness of the course overall as it corresponds to your personal learning style. Please rate the following items as they apply to your learning of the course material. Answer each item by writing the number which best describes your feelings using the 10-point scale associated with each item. Please include any additional comments you may have in item number 3. Don't forget to print your name at the bottom of the page.

Item — Scale: 10 very effective to 1 not very effective

1. Overall, do you feel that the combination of teaching strategies employed in this course (e.g., VCI notes, daily Microthemes, Popular Press Critique, in-class QuickTime™ videos, etc.) were effective in helping you learn the course material better than if the course had been a lecture-only course? _____

Scale: 10 very satisfied to 1 very unsatisfied

2. Overall, how satisfied were you as a learner during the course? _____

3. Additional comments?

Your name (please print) _____ THANK YOU!

Table 5. Results of one-way ANOVA F-tests on survey data captured with Early Feedback Form D. The middle four columns display statistics for students grouped by their dominant Gregorc learning style category (Concrete Sequential = CS, Abstract Sequential = AS, Abstract Random = AR, and Concrete Random = CR).

Item	CS (n = 32)	AS (n = 9)	AR (n = 20)	CR (n = 9)	P-value
1	8.5 ± 1.52	9.2 ± 0.83	8.9 ± 1.12	9.3 ± 1.00	0.20
2	8.4 ± 1.44	8.9 ± 0.93	8.3 ± 1.16	9.4 ± 0.88	0.09

[r] Values displayed are the sample (n) average ± standard deviation.

Figure 5. The classroom in which we teach the course was renovated with a new media system, enabling us to display QuickTime videos during lectures rather than requiring the students to download the video files at campus computer sites outside of scheduled class time.

Analysis of Student Responses by Learning Styles

The frequency distribution of students with a GSD learning style score from the GSD greater than or equal to 32 by category were as follows: CS = 32; AS = 9; AR = 20, CR = 9 (n = 70). The responses to items on the four Feedback Forms (A–D) were analyzed by learning style (Tables 2–6). On Form A (Table 2), only the responses to Item 2d (pertaining to audio summaries of lectures in VCI) showed a significant difference among learning styles. The AS learning style group rated the audio summaries significantly less effective in helping them learn the course material than did the CS and CR learning style groups. The AR learning style group rated this VCI feature more effective than the AS group but less effective than both the CR and CS groups. This is an unexpected result because according to Gregorc (1979), one of the attributes of AS learners is their affinity for listening to instructional content (Table 1).

It is plausible that AS learners used the audio summaries more than the other three learning style groups, but were less satisfied with the quality of this VCI feature. Some of the 37 streamed audio lecture summaries are difficult to hear because the file compression algorithm applied to the audio during production diminished fidelity. Additionally, it is important to note that the results showed that students, independent of learning style, responded that the Web courseware environment (VCI) is a very effective learning tool, giving the overall use of VCI an average rating of 8.6 (± 1.68) across all learning style groups (Feedback Form A, Item 1).

None of the items on Feedback Form B resulted in a significant difference among learning styles (Table 3). However, Item 1b (pertaining to multiple-choice exam questions) resulted in a probability level of 0.085, which is nearly significant. Typically, AR learners do not like restrictions created by unnecessary rules and guidelines, which may explain their dislike of multiple-choice questions.

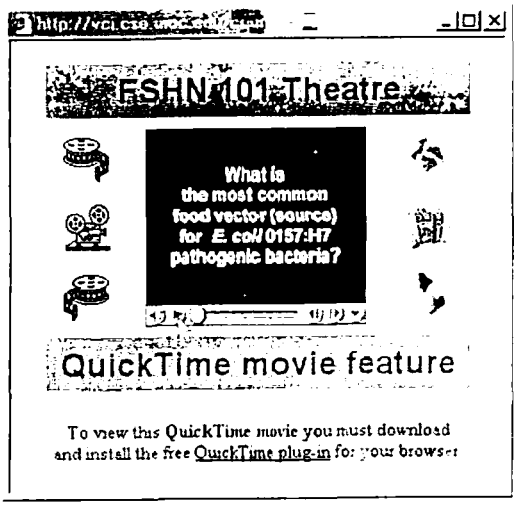

Figure 6. A pop-up video window (enabled by JavaScript™) displays an embedded QuickTime movie that begins with a question to help focus the students' attention on the content. The answer to the question is presented in the video.

It is noteworthy that overall, the four learning style groups liked the true-false questions less than multiple-choice questions (Item 1b versus Item 1c) and disliked final exams (Item 2) much more than hour exams (Item 1a). In general, the students liked the Daily Microtheme (Item 3) and Popular Press Critique (Item 4) more than hour or final exams.

None of the questions on Feedback Form C resulted in a significant difference among learning styles (Table 4). We designed Form C to capture feedback from the students about QuickTime™ (Apple Computer, Inc., Cupertino, CA) videos that are embedded in the lecture outlines available in VCI. A notable enhancement in the classroom facilities occurred between Form A (Item 2c) and Form C (Item 4) were distributed to the students. A new media projection system was installed in the classroom in which we teach the course enabling us to display QuickTime videos during lectures (Figure 5) rather than requiring students to download the video files at a campus computing site outside of scheduled class time. The results from neither Item 2c nor Item 4 were significantly different among learning style groups. However, the students reported that the QuickTime videos were a more effective learning tool when viewed during lectures (mean score of 8.4 [± 1.57] across all learning styles) compared to outside of class (mean score of 5.9 [± 2.64] across all learning styles).

We believe this result is influenced by two factors. First, some students initially reported technical difficulties when downloading the video files at campus computer sites; viewing the videos during class eliminated the need for students to download the media. Further, after playing the videos during lectures, the instructor led discussions about the content and guided the class to answer the content questions that precede each video (Figure 6). In-class viewing and contextualization provided by the discussions enhanced our students' appreciation of the educational content of each video and how it is connected to the topics presented during lectures.

The feedback captured with Form D suggests that students, independent of learning style, believe a combination of teaching strategies is more effective in helping them learn the course material than if content were delivered by lecture only (Table 5, Item 1). The course mean score for Item 1 across all learning style groups was 8.8 (± 1.30). Additionally, there was a high level of learner satisfaction, independent of learning style: the mean score for Item 2 was 8.6 (± 1.28).

Analysis of Student Grades by Learning Styles

While there was no significant difference in the course grades obtained by the FSHN 101 students independent of learning styles (Table 6), we noted that the average course score (percentage of available points earned) for AS learners was the only style group in the traditional 90–100% "A" range. This result implies that AS dominant learners successfully learned the course material that was designed and delivered to accommodate other (non-AS) learning styles. It seems plausible that instructors could teach students who possess one dominant learning style how to adapt to successfully learn from instructional strategies and activities that cater to other learning styles.

Summary

The results from our exploratory study suggest that the selected instructional strategies were effective in teaching students with all four Gregorc learning styles. Employing multiple teaching strategies to accommodate all learning styles exhibited by a group of students is an important concept that may have a profound impact on the effectiveness of classroom instruction. Instructors who are aware that students exhibit different learning styles may be better prepared to modify their pedagogical repertoire (instructional activities, methods, and content) to fulfill the needs and preferences of their students.

The value of the inferences derived from this study is subject to at least four limitations. First, as students gain familiarity with the selected teaching strategies employed in the course, they may moderate their responses during longitudinal feedback activities (the Hawthorne effect [Roethlisberger and Dickson, 1939]) that we employed in this study. Second, the survey instruments (Feedback Forms A–D) did not constrain the user to a pre-determined range of valid responses (1–10) to each item. Students simply wrote a numerical value on the form, resulting in a few occurrences of

eliminated from the data analysis. Third, we used the GSD learning style model exclusively to assess the students' learning styles. We are unable to predict how our findings would differ had we simultaneously used two or more learning style models in a controlled study. Finally, and most importantly, we have reported the results from only one semester in one large enrollment, introductory class. If we have the opportunity to repeat the study in future semesters, we will improve our estimate of the true impact of integrating selected teaching strategies to accommodate student learning styles.

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FSHN 101 Web site
<http://vci.cso.uiuc.edu/courses/FSHN101>

U of I Direct
<http://www.oar.uiuc.edu/register/ mainmenu.html>

Virtual Classroom Interface (VCI)
<http://web.aces.uiuc.edu/aim/vci/Default.htm>