BRIEF COMMUNICATION:
CASE STUDY REPORT

CURRENT DEVELOPMENTS IN NUTRITION

Nutrition Education

Redesigning an Undergraduate Nutrition Course through Active Learning and Team-Based Projects Enhances Student Performance

Regan L Bailey, Violet A Kiesel, Andrea J Lobene, and Peishan Zou

Department of Nutrition Science, Purdue University, West Lafayette, IN, USA

ABSTRACT

Team-based active learning has been associated with enhanced communication and critical thinking skills, and improved clinical competency in other allied-health disciplines, but little is known about this pedagogical technique in nutrition. This study compared content retention and perceptions of a team-based, active learning course redesign intervention in an undergraduate nutrition class pre- ($n = 32$) and post- ($n = 43$) intervention. Assessment scores improved overall (69% to 75%; $P < 0.01$) and within 3 content domains: dietary guidelines (75% to 84%; $P = 0.03$), the exchange system (38% to 49%; $P < 0.01$), and dietary assessment (59% to 73%; $P < 0.01$). Thus, incorporation of team-based active learning was effective in improving content knowledge in undergraduate nutrition students as assessed by performance on exam questions overall and in some but not all content domains. Nonsignificant changes in student evaluations suggest that this is an acceptable, noninferior strategy to facilitate learning in undergraduate courses. *Curr Dev Nutr* 2020;4:nzaa039.

Keywords: active learning, nutrition education, dietetics, curriculum, scholarship of teaching and learning

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Address correspondence to RLB (e-mail: reganbailey@purdue.edu).

Introduction

Almost half of undergraduate students show no significant improvement in critical thinking and complex reasoning during the first 2 y of college (1). One pedagogical approach to enhance these dimensions is to incorporate active learning into the course by creating a student-centered learning environment (2). Active learning has been defined as "any instructional method that engages students in the learning process" (3). In nutrition and dietetics, active engagement of the learner is one of the recommended evidence-informed strategies to enhance critical thinking and problem solving in undergraduate education (4) and results in improved student performance and overall course satisfaction (5, 6). Group or team-based activities are a dimension of active learning that holds tremendous promise because "individuals are more likely to learn more when they learn with others than when they learn alone" (3). Allied health professions are inherently interdisciplinary, so practicing group and team-based techniques in undergraduate education can facilitate mastery in performing as part of a healthcare team (7). Furthermore, team-based learning has been associated with enhanced communication and critical thinking skills (8, 9) and "clinical performance" competency (10) in both pharmacy and nursing, but little is known about this pedagogical technique in nutrition and dietetics. Therefore, the purpose of this study was to compare student performance and satisfaction before and after a team-based active learning intervention in an undergraduate-level nutrition course through the Instruction Matters: Purdue Academic Course Transformation (IMPACT) program (2).

Methods

Description of the intervention

The IMPACT faculty development program at Purdue University is a semester-long course redesign program intended to foster a student-centered active learning environment (2). The program is rooted in self-determination theory that encompasses 3 basic psychological needs—competence, autonomy, and relatedness—that all affect motivational learning (11, 12). As part of the IMPACT program, Purdue faculty members can apply to be fellows, and selected fellows are provided with resources and training to enable them to redesign their course in a way that focuses on student-centered learning.

Complete details of the IMPACT program are publicly available (2). Briefly, program faculty are required to attend weekly sessions for the duration of a 16-wk semester, complete additional readings and assignments, and participate in faculty group and support team meetings to discuss programmatic issues and challenges and share insights on progress. Faculty fellow training focuses on creating or refining learning outcomes and objectives, applying pedagogical approaches for increasing student engagement and achieving learning outcomes, and developing course assessments that align with and effectively measure learning outcomes. Specific models for course transformation depend on the type of course and the needs of the instructor, but all faculty fellows complete and submit a course design plan iteratively throughout the semester.

For the current study, the IMPACT course redesign program was implemented in the Fall of 2018 in a 300-level undergraduate nutrition course titled "Diet Selection and Planning" (NUTR 330). This course satisfies the Accreditation Council for Education in Nutrition and Dietetics core standards for Knowledge for Registered Dietitian Nutritionists (KRDN 2.6 and KRDN 3.3) established for nutrition and dietetics didactic programs, and is therefore required for all nutrition and dietetics majors at Purdue. In both Fall 2017 and Fall 2018, NUTR 330 met in-person for 50 min, 3 times per week. Prior to the redesign, class time was devoted entirely to traditional lecture-based teaching, and content retention was assessed via summative multiple-choice exams (**Supplemental Table 1**).

Per the IMPACT course redesign process, first, broad course-level outcomes were constructed along with more narrowly defined measurable learning objectives for students with a focus on Bloom taxonomy (13). Next, assessment methods were matched to each learning outcome. The IMPACT program recommends faculty fellows balance formative and summative assessments in their courses; thus, the redesign incorporated shorter, more frequent summative assessments of knowledge and critical thinking, compared with the traditional course format that included 3 larger exams. Because the IMPACT redesign goal for NUTR 330 was to make the class more student-centered, the next step was to transfer content from lecture-based passive learning to conveying course concepts through in-class, group-based active learning projects in combination with lectures. Prior to the redesign, students worked individually on homework assignments outside class; after the redesign, team-based learning activities during classroom time replaced individual homework assignments.

The IMPACT program encourages faculty fellows to consider how the learning activities they develop meet students' basic psychological needs of autonomy, competence, and relatedness as outlined in self-determination theory (2, 11, 12). Therefore, particular attention was given to designing and implementing the in-class active learning projects. For all group activities, students could choose their own groups, and students were assigned (leader) to or selected 1 of 4 (ideally) or 5 roles (with optional wildcard as needed) within the group: leader, recorder, timekeeper, member, or wild card (**Supplemental Table 2**). The wildcard role was used if the group size was 5, but was not needed for groups of 4 students. Some activities allowed students to choose which version of the activity they completed or allowed them to choose their topic (e.g., choosing a country for the cultural foods project). Allowing students to make these choices satisfied their need for autonomy, and working together as part of a group satisfied their need for relatedness. Each student was required to serve as the group leader at least once during the semester. After completing each activity, students were asked to complete peer evaluations and provide feedback on team members' performance using both a Likert scale for 6 domains and open-ended items for more detailed feedback (**Supplemental Table 3**) (14). Peer evaluations were graded for participation only and were reviewed each week by the course administrative team. Throughout the semester, 11 in-class group activities were scheduled, with the scores from 10 of 11 activities included in the overall course grade. Providing students with frequent opportunities to use their knowledge and skills to complete activities, ensuring that students have the opportunity to lead their group, and providing them with feedback on their performance in the form of grades was intended to satisfy their need for competence.

This analysis compares student exam scores and evaluations of the course and the same instructor preimplementation (Fall 2017; $n = 32$) and postimplementation (Fall 2018; $n = 43$) of the IMPACT program intervention. In both semesters, nearly identical topics and content were delivered, with some topics condensed or eliminated post-IMPACT to accommodate the class time needed for group activities. An abbreviated course schedule and summary of topics covered in both semesters is provided in **Supplemental Table 4**. Because the subject matter was nearly identical, multiple-choice questions used for exams pre-IMPACT (Fall 2017) were reused for the more frequent assessments post-IMPACT (Fall 2018). Student performance in pre- and post-IMPACT was evaluated and compared using these exam/assessment questions, which were administered closed book and not returned to students upon completion. At the end of both semesters, students assessed the course and the instructor via the usual online course evaluations, which are administered in a standardized way by the University. Student ratings and comments from these evaluations were used to assess students' satisfaction with the course pre- and post-redesign.

Statistical methods

Independent *t* tests were used to compare overall scores on exam question items between pre-IMPACT (Fall 2017; $n = 32$) and post-IMPACT (Fall 2018; $n = 43$). Individual component scores for specific constructs of nutrition knowledge were compared with the Wilcoxon rank sum test, with exact *P*-value option, given the nonnormal distribution and relatively small sample sizes using SAS software (version 9.4; SAS Institute Inc., Cary, NC, USA) (15). Summary statistics were used to present anonymous student feedback data at the end of the course (pre- and post-IMPACT) and specifically on the impressions of the IMPACT course redesign (post-IMPACT only). This analysis of deidentified student data was considered exempt from the Purdue Institutional Review Board (PROPEL #03842722). Statistical significance was set at $P < 0.05$.

Results

Based on 99 overall exam questions, the percentage of correct answers changed from a mean of 73% to 76% from pre- to post-IMPACT intervention (**Table 1**). Of the 99 total assessment questions, 52 were based on redesigned active learning activities. Within these 52 exam questions, the percentage of correct answers post-IMPACT was significantly higher than that pre-IMPACT (75% vs. 69%, respectively, $P < 0.01$).

TABLE 1 The percentage (± SD) of correct exam questions overall and by content domain constructs between pre- and post-intervention with Instruction Matters: Purdue Academic Course Transformation (IMPACT)

	No. of questions	Pre-IMPACT $n = 32$	Post-IMPACT $n = 43$	P value[1]
Overall score	99	73.4 ± 8.7	75.9 ± 7.0	0.20
Redesign score	52	69.2 ± 10.0	75.4 ± 7.1	<0.01
Topics/component domains				
Dietary assessment [2]	6	58.6 ± 17.2	73.0 ± 21.4	<0.01
Understanding nutrition research[2]	4	65.9 ± 20.6	63.1 ± 28.3	0.92
Nutrition assessment	5	83.6 ± 16.2	78.6 ± 21.4	0.39
Dietary patterns	7	76.8 ± 17.7	72.8 ± 15.6	0.33
Dietary guidelines[2]	7	75.4 ± 15.9	83.6 ± 16.4	0.03
General knowledge	9	76.0 ± 13.0	80.7 ± 13.6	0.18
Dietary reference intakes	6	83.3 ± 16.1	80.5 ± 17.4	0.53
Dietary supplements	7	62.1 ± 20.1	61.8 ± 23.4	0.98
Behavior modification and lifestyle	3	82.3 ± 18.9	84.1 ± 18.4	0.74
Food allergies and intolerances[2]	8	78.1 ± 15.6	83.3 ± 14.5	0.15
The exchange system[2]	8	38.3 ± 17.9	49.1 ± 16.8	<0.01
Intuitive and mindful eating[2]	4	90.6 ± 17.7	91.7 ± 14.3	0.91
Meal planning[2]	5	87.9 ± 14.1	80.5 ± 17.2	0.07
Dining out and menu labeling[2]	5	68.1 ± 29.6	78.0 ± 19.9	0.22
Smart shopping and label reading[2]	5	77.5 ± 22.6	82.4 ± 15.6	0.50
Obesity	7	90.6 ± 11.2	87.8 ± 13.8	0.47
Cultural aspects of food	3	67.7 ± 29.9	72.2 ± 23.2	0.56

[1] P value for overall score compared by t test and component scores derived from the Wilcoxon exact test.
[2] Indicates active learning implementation in the classroom.

Among the topics/content domains, the students performed significantly better in "dietary assessment," "the Dietary Guidelines for Americans," and "the exchange system," which has recently been renamed the food choice system. However, no significant differences in exam performance were observed within other content domains before and after the intervention. Lectures and content that were not made into active learning projects displayed a nonsignificant change in student performance. Scores on the domain of menu planning displayed a nonsignificant decrease, despite having an active learning project devoted to this topic (~88% to 81%), suggesting that the active learning assignment did not appropriately emphasize material covered on the exam, and should be re-evaluated for future semesters.

The majority of students, 25 of 32 (78%) pre- and 36 of 43 (84%) post-intervention completed the course and instructor evaluation survey. The median values of student rating from end-of-course evaluations for both the instructor (4.8 post- compared with 4.6 pre- of 5) and the course (4.6 post- compared with 4.3 pre- of 5) were higher after the IMPACT intervention, but without statistical significance based on Wilcoxon exact 2-sided P value.

After IMPACT intervention, more students provided written positive comments for the instructor (64% compared with 52% for post- and pre-IMPACT, respectively), and provided fewer suggestions for improving the course (47% compared with 52% for post- and pre-IMPACT, respectively). Whereas course and instructor ratings improved slightly, written student feedback about the team-based project revealed that not all students participated equally within the group. Initially, team roles were assigned to facilitate participation, but autonomy in selecting group roles was implemented after the first few projects. Students preferred the ability to self-select their team and roles (e.g., "I liked being able to choose my group instead of being assigned a group so that I knew the people I worked with would all do a fair share of work"). Additionally, students commented that the peer feedback form was repetitive (e.g., "I felt as if I was writing the same thing every time" and "don't need as many peer reviews").

Discussion

Active learning through team-based projects effectively improved content knowledge in undergraduate dietetics and nutrition students in terms of overall performance and in the content domains of dietary assessment, the Dietary Guidelines for Americans, and using the exchange system. The exchange system has historically been difficult for our students to retain. Before the IMPACT intervention, we provided lecture-based instruction for the exchange system along with 2 quizzes and exam questions cumulatively throughout the semester. In the redesigned course, we implemented "exchange week" and devoted 3 course periods to instruction and active learning strategies. We observed a significant improvement in student performance (i.e., 11 percentage points); however, post-IMPACT the scores were still of concern with only half of exam questions being answered correctly, suggesting that more focused efforts on this domain are still needed. Similarly, whereas performance on the diet assessment domains improved with the new mode of content delivery, only 73% of exam questions were answered correctly.

There were some challenges with this redesign approach. The shift from lecture-based course delivery to using classroom time for team-based projects resulted in a loss of time to cover all of the content of the course; difficult decisions had to be made about which portions of the course should be cut in order to focus more deeply on other top-

ics. In doing so, 3 lectures on dietary patterns were condensed into 1 lecture. We observed no significant differences on exam scores in the "dietary patterns" domain, which provided a sense of comfort that the key concepts were preserved despite a reduction in time devoted to covering this topic in depth (Supplemental Table 4). Another domain that was reduced was "overweight and obesity," because this topic is covered extensively in other courses, for example, medical nutrition therapy, and did not significantly affect exam performance in this domain. In addition, some topics had to be removed entirely. The topic of eating disorders was removed from the course, which was always a highly rated part of the course historically but is also covered in other courses in our curriculum. Prior to the redesign, NUTR 330 had special topics lectures on controversial topics in nutrition such as low-calorie sweeteners and macronutrient distribution and satiety, which were delivered by outstanding faculty in our program. These lectures were also excluded to accommodate the course redesign. A key takeaway is that the variety of topics provided to students must be balanced with the temporal demands for active learning on a course-by-course basis.

Restructuring the course required a dedicated effort on the part of the course instructors, and can have potential implications for the learner. In order to facilitate group-based projects and assessments, much upfront time was devoted by the course administration not only to complete the IMPACT program, but also to plan and facilitate multiple team-based projects during the course of the semester. Although this can seem like a limitation, an analysis of multiple IMPACT-associated faculty and instructors judged that the time spent was worth the outcome, and the program was enjoyed for forming new networks to share ideas, for teaching support, and for providing resources to support both the teacher and the learner (16). The expectations for university faculty are to demonstrate proficiency in researching, teaching, and service (17); as such, time management and devotion to teaching expectations within the Carnegie-classified "doctoral university" context generally comes at the expense of research time and is associated with occupational stress (18). Limited faculty time and lack of institutional support (e.g., space available for active learning classrooms and other resources) have been barriers to implementing active learning in the classroom noted in the literature (19). Not all aspects of active learning are positive for all learning types (3), and learner characteristics such as gender identity, race/ethnicity, country of origin, as well as physical, social, and psychological factors (e.g., anxiety, disability) can affect the experience of active learning differentially (20). Additionally, some course types can suffer from a loss of information transfer efficiency as a result of course time devoted to activities rather than traditional lecture-based strategies (21). Among our students, although the course redesign was received generally positively, there were a few negative comments that primarily focused around the required peer reviews that accompanied all the group assignments. Clear and predefined peer evaluation tools helped to facilitate the group-based projects (see Supplemental Tables 2 and 3) and shaped students' expectations for group work. Additionally, whereas peer feedback has been demonstrated to enhance a more student-centered learning environment and foster knowledge competence (14), NUTR 330 students, in the end of the semester evaluation, perceived using the same template for peer feedback as repetitive. Future course redesigns will consider different formats for peer evaluations. Additionally, a more formal procedure will be developed to handle students who are receiving poor feedback from other students in the group.

To date, most efforts to incorporate active learning into the classroom seem to be undertaken individually by instructors. It is not well known how institution-level support for course redesign could ultimately affect student performance and satisfaction in nutrition and dietetics courses. In a previous study of instructors participating in an institution-level training program at Iowa State University (22), the authors found that student performance on exams significantly improved compared with the previous year, and students provided positive feedback about the course and the activities. This study, together with our findings, suggest institution-level programs that empower faculty to develop more student-centered courses are beneficial for nutrition and dietetics (22). The success of similar institution-level course redesign programs when implemented with other dietetics courses should be explored in order to add to this scarce body of literature. Future work should also focus on improving efforts to provide instruction guided by self-determination theory (23).

In conclusion, active learning encompasses many different potential and positive techniques to foster student engagement and autonomy, and offers opportunities for differentiated instruction for a diverse group of learners (24). Active learning has already been shown to be effective in science (3, 25–27) and allied health education (28–30). Team-based pedagogical strategies appear to be effective at improving content retention and critical thinking (9, 31, 32), and could enhance performing as part of a healthcare team (7).

Findings from this study provide a compelling rationale for further course restructuring to incorporate active learning within undergraduate nutrition and dietetics courses. Nonsignificant improvements in student evaluations suggest this was an acceptable, noninferior strategy to facilitate learning in undergraduate courses. However, future studies with larger samples sizes and with different instructors in different nutrition science and dietetics courses are needed to confirm our findings.

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