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Active Learning: A Shift from Passive Learning to Student Engagement Improves Understanding and Contextualization of Nutrition and Community Health

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Abstract: Challenging the notion of "teaching by telling," active learning utilizes a student-oriented approach by emphasizing the concept of knowledge retention through peer interaction. To further examine the potential of active learning, we created a workshop based on didactic education and student collaboration. Participants included undergraduate students from traditionally underrepresented and disadvantaged backgrounds. The workshop was part of our summer academic enrichment program run in an urban, medically underserved community. The workshop focused on clinical and biochemical nutrition, wherein students synthesized information by discussing dietary choices and the socioeconomic aspects of nutrition. Student reception of the workshop was adjudged by anonymous surveys. The survey questions were designed to gauge how the workshop objectives were achieved. Cronbach alpha (0.276) confirmed that there was more than a single theme contained in the questions. The majority of students (97%) agreed that the workshop met the learning objectives: (1) acquire basic clinical knowledge, (2) gain a better understanding of nutrition, (3) formulate a linkage between clinical nutrition and disease, and (4) benefit from peer interaction. Students' performance in the post-quiz (100% correct answers) had improved significantly compared to the pre-quiz (25% correct answers) suggesting acquisition, understanding and application of nutrition aspects taught in the workshop. Overall, the present study demonstrated the engagement and understanding of students with respect to learning about nutrition and community health in an active learning setting. These types of active-learning-based sessions may have broad applicability for any academic discipline to improve student engagement and knowledge retention.

Keywords: active learning; student engagement; nutrition education; community health; undergraduate education

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1. Introduction

1.1. Premise of the Study: Active-Learning-Based Pedagogy

The conventional paradigm for education has often included lecturing via direct instruction, reading textbook excerpts, and highlighting literature. In fact, this didactic form of lecturing has predominantly controlled the classroom since the establishment of universities in Western Europe over 900 years ago [1]. However, modern theory has found that this passive method of teaching has not proven to be the most effective method of thoroughly comprehending all material [2]. As a result, experts have suggested a shift from the previously popular model of instructor-based teaching to a more student-oriented approach, known as active learning. This educational model is revolutionizing the means by which we educate students by altering the conversation to prioritize the student's perception of the information provided to them [3,4].

Definitions of active learning include: (1) active construction of meaning, (2) gaining both declarative and procedural knowledge, (3) integration and transference of knowledge between domains, (4) collaborative comparison of reasoning, and (5) meaningful learning through articulation [5,6]. This engaging style of education can be applied in a vast variety of settings including, but not limited to, the fields of humanities, business, art, science, technology, education, and mathematics [7,8]. Examples of active learning exercises range from designing research projects to constructing meaningful classroom debates and demonstrations. This pedagogy ultimately encourages students to fill self-identified gaps of knowledge to later incorporate into a preexisting network of understanding, therefore providing a practical context through which students create a meaningful educational experience [2].

Literature suggests that active learning approaches can be very effective for improving knowledge retention, communication skills, and self-directed learning and lead to deeper understanding of the material [9–12]. A comprehensive compilation of a variety of published active learning methods that can be used by medical educators emphasizes this aspect [13]. A study by Michel et al. showed that active learning can lead to improved cognitive outcomes, and highlighted the importance of delivery method on learning outcomes [14].

Although active learning has been gaining momentum in recent years, discipline-specific and goals-specific studies are required to determine efficacy of this pedagogy. For example, in an animal physiology course, Minhas et al. showed that integration of active and passive learning into undergraduate courses may have greater benefit, in terms of student preference and performance, than either method alone [15]. Another study reported that awareness training can result in significant attitude changes while, contrary to published literature and prior assumptions, impairment simulations have a moderate effect on student attitude toward people with impairments [16]. Douglas emphasized the importance of carefully designing learning activities to ensure that these enable effective, supported learning, and, also, that it is necessary to highlight key concepts in class as students may not necessarily read the pre-session materials provided [17].

1.2. Nutrition Education of Health Care Professionals

It has been discussed that there is a need to improve the nutrition training that health care professionals receive, as there is a paucity regarding this aspect in the current education environment. This paucity, in turn, results in health care professionals having inadequate expertise to provide appropriate nutrition counseling to their patients [18,19]. Thus, we need to improve the nutrition training of health professionals which, in turn, will improve patient care [20]. This notion has prompted the current increased awareness about nutrition education for health profession students, in both preclinical as well as clinical years. The overall aim of the present study was to explore the efficacy of active learning with regards to student engagement and knowledge retention using nutrition as a foundation. We also aimed to increase student interest in nutrition by using real life cases that involve nutrition pathology. This workshop was built on students teaching their peers. Interest in peer teaching is gaining attention in health profession education. Literature suggests that peer teaching has dual benefits, in that it can lead to the enrichment of students, both academically and professionally, as students share cognitive as well as social congruence [21–23]. Our goal is well supported by literature as various approaches, including the use of digital workbooks in flipped nutrition education and diet analysis exercises, have been successfully used for teaching nutrition [24,25].

1.3. Socioeconomic Considerations

This particular study implemented active learning in an enrichment program designed for premedical students (Premedical Urban Leaders Summer Enrichment -PULSE). Developed by Cooper Medical School of Rowan University, which is situated in an underprivileged community, this six-week annual enrichment program provides academic,

clinical, research and service-learning opportunities for college undergraduates interested in healthcare professions. The program emphasizes exposure to the medical field of students from backgrounds generally under-represented within the discipline. Support for similar programs to promote recruitment of underrepresented minority students to medical schools has been described in literature [26]. Ultimately, it aims to empower individuals to serve in an urban setting by contextualizing the challenges unique to the environment.

Due to our medical school's placement in a city of low socioeconomic status, basic needs, such as education, housing, food, and healthcare, are limited for many of the surrounding residents. Over 35% of the population is below the poverty line, with the Census Bureau ranking the city as the poorest in the nation. In addition, the local graduation rate is 67% compared to the national average of 85%. These socioeconomic and educational disparities, combined with strong ethnic diversity and medical inequalities, necessitate a distinctive holistic approach to intervention techniques.

1.4. Nutrition in a Food Desert Community

One particular domain that is a challenge for the community is that of nutrition. More specifically, the city's residents suffer from poor quality diets due to a wide variety of challenges, including financial shortages, scarcity of nutrient-rich foods, and lack of transportation to more distant suppliers. This lack of resources disproportionately affects urban populations across the globe. Therefore, these communities are described as "food deserts," defined as areas with limited access to affordable, healthy food options; namely, fruits, vegetables, and whole foods [27,28].

A study showed that beyond accessibility, the nutrition content of meals varies proportionately to household income. Lack of food suppliers subsequently creates food insecurity, and often turns the consumer towards cheaper, less nutrient-dense foods [29]. Accessibility to food is a major challenge in our area due to lack of adequate food suppliers, lack of affordable transportation and lack of healthy nutrition choices and many residents live at significant distances from a grocery store. Our community has thus been declared a 'food desert'.

2. Materials and Methods

2.1. Objectives of the Session

The present study aimed to utilize the enrichment program to educate undergraduate students on the biochemistry and economics of nutrition via active learning techniques. The main objectives of the session addressed the following: (1) teach the function, biochemistry and significance of vitamins, (2) identify the clinical significance of related pathologies, (3) highlight the economic implications and practicality of a well-balanced diet, (4) apply all aforementioned information via an educational exercise, and (5) encourage self-reflection on personal nutrition. Ultimately, through the workshop, it was expected that the students would gain further insight into the effects of income and education level on the purchasing patterns of those in disadvantaged urban communities. Overall, the present study aimed to assess the level of engagement and understanding of students learning about nutrition and community health in an active learning setting.

2.2. Participants

We have a summer pipeline program (PULSE) at our school. This is separate from the undergraduate and graduate programs that are taught at our university. This pipeline program is offered to undergraduate students from various national universities who are interested in pursuing medical school. These students are described as pre-medical students in this context. Academic criteria to qualify for the PULSE program stipulate that the students need to have completed at least one year of college, including a course in biology or chemistry, and have a grade point average (GPA) of 3.0 or higher. The PULSE program is created to help students of backgrounds generally under-represented within the discipline in the pursuit of their goals of careers in the medical field. The PULSE program is

conducted over one summer. The class size of the PULSE program is determined by several factors, including financial support. It starts with a biochemistry course. The present study describes a nutrition-based interactive session carried out as part of this biochemistry course. Attendance and participation at this nutrition session was mandatory as it was part of their didactic. Thirty-eight students were admitted to the pipeline program, all of which thus participated in this mandatory nutrition workshop. Both male and female students participated and there was no significant difference in gender distribution (18 males and 20 females).

2.3. Overview of the Workshop Procedure

The workshop had four learning objectives: (i) acquire basic clinical knowledge and skills, (ii) gain a better understanding of nutrition, (iii) formulate a linkage between clinical nutrition and disease, and (iv) experience and benefit from peer interaction. The workshop was carried out in a single lecture hall with one faculty facilitator, who created the activity. Students were randomly assigned into eight groups of four to five students each. The arrangement of tables allowed the groups to be physically separated from each other to facilitate discussions with least noise disturbance from neighboring groups. The students were given a pre-quiz to take as a group that assessed their base-level knowledge for the nutrition aspects under discussion. This was followed by a presentation from the faculty facilitator, as described below. In the beginning of the presentation, the format and the learning objectives of the workshop were explained to the students. Following the presentation, each group worked on the workshop quiz (post-quiz) with case-based questions. All the students were given paper copies of the slides of the presentation and the post-quiz. The groups were asked to work on all of the eight case-based questions in the post-quiz and were told which question and answer they would be presenting to the class. They were also asked to build a nutritional and economically balanced meal using resources provided in the presentation. Two groups each were assigned to create a breakfast menu, a lunch menu, a dinner menu or an afternoon snack menu. After the conclusion of the group discussions, completed post-quizzes were collected from all groups (one quiz per group). Each group then presented the answer to the question assigned to them along with the meal they built to the entire class, identifying the macro-and micro-nutrients present in each meal. Other groups were encouraged to ask questions of the presenting group. The students then participated in an open discussion session, wherein they had the opportunity to ask the faculty facilitator their nutrition-related questions. The interactive workshop lasted approximately two hours.

2.4. Details of Workshop Materials

2.4.1. Faculty Presentation

Students were given a 25-min presentation by the faculty on nutrition, with a focus on clinical relevance and socioeconomic factors affecting patient populations. Four clinically significant micro-nutrients were selected to introduce to the students, including vitamins A and D, to represent fat-soluble vitamins, and vitamins B-12 and C, to represent water-soluble vitamins. The presentation outlined the different vitamins with respect to their functions, dietary sources, underlying biochemistry, deficiency and toxicity symptoms, and additional relevant information, if any, as highlighted in Table 1. The outline also provided resources, such as choosemyplate.gov and food prices from local grocery stores.

Table 1. Highlights of aspects covered in faculty presentation *.

Nutrient	Functions	Sources	Deficiency	Toxicity	Take Home Messages
Vitamin A	Night vision, gene expression, immunity, antioxidant properties, bone remodeling	Plants (green, orange, and red vegetables) and animals (egg yolks, liver, fish oil, etc.)	Vision problems (age-related macular degeneration), increased susceptibility to infection, acne, psoriasis	Bone pain, dermatitis, hepatosplenomegaly, nausea, diarrhea, birth defects	Largest worldwide deficiency, can be prevented/treated with vitamin A-rich sweet potatoes and "Golden Rice"
Vitamin D	Maintain calcium levels, bone health	Sunlight, milk, cod liver oil, salmon	Rickets (children) and osteomalacia (adults)		Deficiencies are widespread, due to lack of sunlight exposure
Vitamin B12	Red blood cell formation, neurological function, DNA synthesis	Animal sources, fortified foods, supplements	Pernicious anemia, anemia, neurological symptoms		Requires intrinsic factor for absorption and can be stored in liver for years
Vitamin C	Collagen stabilization, antioxidant properties	Fruits and vegetables	Scurvy, weak connective tissue		Deficiencies can cause easily bruised skin, soft swollen gums, decreased wound healing and hemorrhaging, and osteoporosis

* Nutrition information used is readily available in text books and published literature; examples of some nutrition textbooks are given here [30–32].

2.4.2. Pre- and Post-Quizzes

The pre-quiz included eight fact-based, multiple-choice questions that paralleled the aspects asked in the post-quiz. For example, for the two post-quiz questions shown in Table 2 below, the pre-quiz asked to identify dermatitis as a symptom of vitamin A toxicity and intrinsic factor being important for the absorption of vitamin-B12, respectively. The post-quiz included eight case-based questions rooted in common clinical scenarios. Two examples of cases utilized for the post-quiz, including corresponding discussion questions, correct answer choices and key take away points emphasized to students via group discussion, are shown in Table 2.

Discussion questions were designed to be thought provoking and required an in-depth understanding of underlying biochemical principles for accurate resolution. It is significant to note that the stem for each question provided adequate information, based on the presentation, to understand the cases. Each question corresponded with an answer and a set of key points compiled from the presentation portion that were disclosed in a group debrief discussion. The importance of the students' ability to explain underlying concepts during the discussion question was emphasized.

Table 2. Examples of cases solved by the students working in groups.

Case Background	Case Question	Answer	Key Points
A 36-year-old woman decides that she should put in more effort to be healthy. She starts going to the gym. Her diet is well balanced. However, she is not convinced that she is doing everything to be healthy. Her friend advices her to go to a nutrients supplement store. She goes to the nearest health food store to buy dietary supplements to consume on a daily basis. She is very happy with her decision. However, a year later she has bone pain, nausea, diarrhea, and dermatitis. She also experiences weight loss which was not intentional. She goes to a doctor who orders a few laboratory tests. Laboratory findings show that her liver and spleen have become larger. The doctor suspects overdose of a nutrient.	An excessive intake of which one of the following nutrients is most likely responsible for her symptoms?	Vitamin A	• Vitamin A is a fat-soluble vitamin. Hence, it accumulates in the spleen and liver leading to organ enlargement. • Symptoms arose 1 year after she started taking supplements indicating that fat soluble vitamins, such as vitamin A, are stored in the liver and can lead to toxicity. • She is a perfectly healthy 36-year-old female ultimately indicating a possible outside process giving rise to her symptoms.

Table 2. *Cont.*

Case Background	Case Question	Answer	Key Points
A 75-year-old patient eats well and takes 30 min walks daily. However, for several weeks he has been feeling tired. He goes to see his doctor, who orders a few laboratory tests. The tests show that the patient has anemia.	Based on further laboratory tests, the doctor suspectssignificant loss of intrinsic factor in this patient and orders monthly injections of which one of the following vitamins?	Vitamin B12	• A primary role of vitamin B12 is to help make healthy red blood cells. A lack of this vitamin may ultimately lead to anemia. • Intrinsic factor aids in absorption of vitamin B12 in the intestine. Thus, failure to produce intrinsic factor may result in anemia. • The ability for gastric parietal cells of the stomach to produce intrinsic factor may decrease with age. As a 75-year-old, this patient may be exhibiting an age-related decline in intrinsic factor.

2.4.3. Evaluation of Student Perception of the Workshop

The survey data presented here was from the anonymously obtained session evaluations by the students. The data was not collected primarily for this study. It was collected for routine education purposes in order to evaluate the session for future improvements. At our school, students routinely complete anonymous surveys after completion of education sessions. The protocol for administering the anonymous paper surveys was set as per the guidelines by our University's Human Subjects Protection Program via Institutional Review Board (IRB). The study authors received approval from IRB to conduct the paper surveys and also to use the workshop data for publication. The students were informed that the evaluation of this session was voluntary and anonymous and did not affect their grades in any way. No student was excluded based on ethnicity or race, school status or socioeconomic status. There were no personal identifiers including name, place, time etc. on the surveys collected, to allow students to feel safe to voice their opinions. The paper survey was distributed to the students at the end of the nutrition workshop. The students were asked to drop these off in a box at the end of the lecture hall without contact with the workshop facilitator. All 38 students who participated in the workshop chose to complete the surveys.

The survey contained four 5-point Likert scale [33,34] (1: strongly disagree, 2: disagree, 3: neutral, 4: agree and 5: strongly agree) statements and one open-ended question. The question statements corresponded to the objectives of the workshop and were as follows: (i) The 'Nutrition workshop' was informative. (ii) The 'Nutrition workshop' made you think about your own nutrition. (iii) The 'Nutrition workshop' demonstrated how nutritional problems can lead to diseases. (iv) You enjoyed working with your classmates. The open-ended question then asked for any comment on the workshop with respect to its structure and usefulness.

Quantitative analysis of the student responses received for the 5-point Likert scale questions was carried out, while qualitative analysis was carried out for the student responses received for the open-ended question to comment on the structure and usefulness of the workshop. The quantitative analysis was done primarily through exploratory factor analysis (EFA) [35] with varimax rotation to provide an understanding about how various subsets of factors within the questionnaire were related. This method allows the study of links between themes or threads in order to understand the interplay between factors studied. The EFA was confirmed via the Cronbach alpha coefficient calculation to determine the internal consistency for the group of questions at large. The Kaiser-Meyer-Olkin Test was then utilized to ensure that data was suitable for Factor Analysis. Next, Bartlett's Test for Sphericity was utilized to rule out any homogeneity of variance [36,37].

3. Results and Discussion

The overall aim of this study was to explore the efficacy of active learning with regard to student engagement and knowledge retention. By providing students with a brief

overview of material followed by a case study and discussion-based learning, students were able to engage with the material and understand its relevance to both themselves and to the society around them.

3.1. Student Performance in the Pre-Versus Post-Quizzes

As we taught new material and new skills in the form of case-solving, it would not have been a fair measure to give the students a pre-quiz that included similar case-based questions as shown in Table 2 above. We did evaluate the base level knowledge of the students for the nutrition aspects discussed in the workshop by asking them to take a pre-quiz as a group at the beginning of the session. Only sixteen out of a total of sixty-four questions asked were answered correctly (25%). In contrast, all the eight groups were able to answer all the eight questions correctly in the post-quiz. Thus, a total of sixty- four questions were answered correctly (100%) in the post-quiz.

3.2. Student Perception of the Workshop

All 38 participants that participated in the activity filled out the quantitative sections of the survey. As the surveys were voluntary, four students chose not to write responses to the open-ended question. Thus, 34 responses were received for the qualitative section. The Likert scale data is shown in Figure 1, with students identifying the session's strengths being primarily informative and applicable to understanding disease states. The mean scores for the learning objectives of being informative, getting students to think about nutrition, translating knowledge about nutrition into knowledge of diseases, and students enjoying peer interaction were 4.9, 4.5, 4.8, and 4.7, respectively, with 5 indicating strong agreement. Thematic analysis of student answers to the open-ended question, "please comment on the structure and usefulness of the nutrition workshop" highlighted these positive aspects: (i) informative and engaging nature of the presentation and cases, (ii) applicability of real-life cases, (iii) teaching to, and learning from, peers, and (iv) logical thinking and interactive ways of learning (Table 3). One criticism expressed a concern that the workshop was too dense with information, but was otherwise engaging.

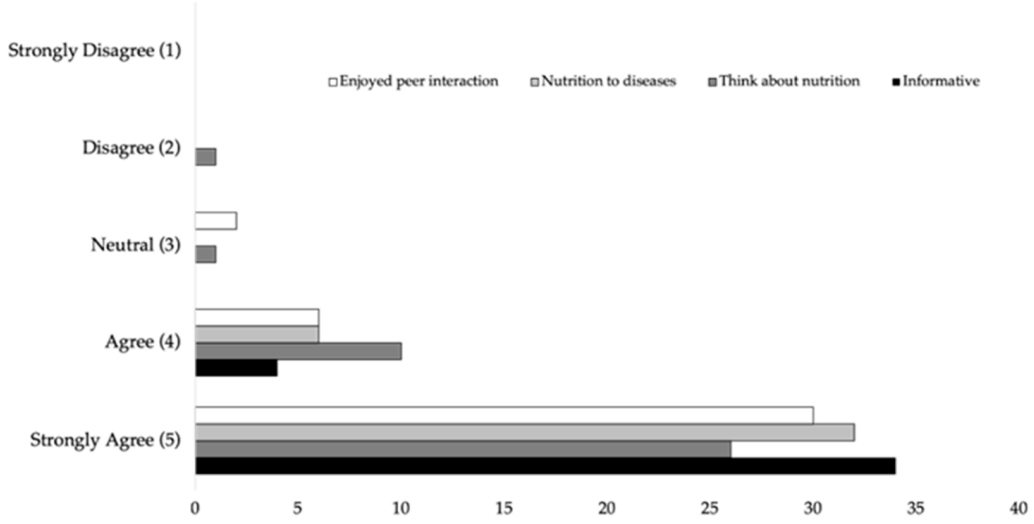


Figure 1. Quantitative responses utilizing the Likert scale from students regarding various aspects of the nutrition workshop presentation, organized by learning objectives: (1) Acquire basic clinical knowledge and skills ("Informative"), (2) Gain a better understanding of nutrition ("Think about nutrition"), (3) Formulate a linkage between clinical nutrition and disease ("Nutrition to disease"), and (4) Experience and benefit from peer interaction ("Enjoy peer interaction"). The mean scores for the learning objectives of being informative, getting students to think about nutrition, translating knowledge about nutrition into knowledge of diseases, and students enjoying peer interaction were 4.9, 4.5, 4.8, and 4.7, respectively, with 5 indicating strong agreement.

Table 3. Qualitative data collected from students' responses to the workshop.

Themes	Student Responses
Informative & engaging nature of the presentation and cases	1. Extremely informative and fun. 2. Enjoyed everything! Best nutrition workshop I've ever been to! 3. Very informative and entertaining. 4. Thank you for the wonderful presentation!!! All the vitamins provided were very informative and interesting. I loved this! 5. Great workshop. 6. Very informative and organized. 7. It was very informative and I enjoyed it. 8. Very informative, learned new information. 9. It was very informative, and fun to do. 10. I learned a lot and it was fun and engaging. 11. I really liked the power-point and having my own copy to use for later. 12. The workshop was structured well and very useful. I learned a lot and enjoyed it. 13. I thought this workshop was fun and interesting. 14. The structure and instruction were very good. The presentation was helpful. 15. Very useful. 16. The nutrition workshop is very informative and clearly demonstrates how important nutrition and health is. 17. Very detailed and interesting. 18. It was very informative.
Applicability of real-life cases	1. I was very interested and informed and became aware about my own health. 2. Very useful and made me think about my own eating habits. 3. Explaining how to organize a balanced meal including fruits, vegetables, proteins, grains, and dairy was most useful. 4. The structure of the Nutrition workshop was well organized and the instructor stayed on topic. The Nutrition workshop will help in the future for if I ever have a deficiency or a patient. 5. It went more in depth about the importance of supplements in one's diet and the consequences that insufficient intake can lead to. 6. This nutrition workshop is very useful for me because now I can actually see symptoms and understand what kind of vitamin is missing. 7. Given that I am planning to be a doctor (as are most of us), it was helpful in understanding the nutritional background and how to accommodate a patient's financial strain (also teaches me how to pay for my meals efficiently).
Teaching to and learning from peers	1. Very interactive and informative. I enjoyed the structure because it taught about the importance of nutrition in a fun, yet educational way. Also, not only did we learn from the instructor, but from our classmates as well. 2. It helped me learn more about nutrition and it was a fun and effective way to learn to work together with other peers, also good way to remember things. I liked how we got to do our own case study in a group.
Logical thinking and interactive way of learning	1. I enjoyed the workshop. It was eye opening and interactive. 2. In regards to the structure, I think the workshop was well put together because of the variety. By this I mean there was a lecture with interactive activities that were simple yet fortifying. I think this will be useful for me in regards to academics and something fun to talk about with friends. 3. I enjoyed how we got to solve cases and make our own meal instead of just being lectured. 4. It was easy to follow and it was interesting. 5. I liked that the workshop was very interactive-it helped me pay attention better. 6. She was very energetic and knew the material very well. She was also very interactive and really got people to participate.
Excessive information	1. The lecture was a little too dense with information. However, it was a very good informative session with fun activities.

The integration of active learning within the workshop curriculum proved to be an effective method for improving knowledge retention, communication skills, and self-directed learning. Based on post-activity responses, students responded positively to the structure of the workshop, with the majority of students describing the workshop as "informative", "engaging", "entertaining", or some combination thereof. The reasons for positive feedback displayed many aspects unique to the active learning style format of the workshop. Some students reported that they enjoyed learning from their peers, stating, for example, that the experience was "a fun and effective way to learn to work together with other peers as well as a good way to remember things". Due to the involved nature of active

learning techniques, students were able to gain invaluable experience and solidification of concepts from their peers. Peer-teaching was an integral part of this activity. It has been suggested that peer teaching benefits the students academically and professionally because the participating students share cognitive and social congruence [38].

Another aspect of the workshop, unique to active learning, was the ability of students to instantly contextualize the information they were given. Several students enjoyed solving cases and viewed it positively in comparison to typical didactic lectures, stating that the activities were "simple yet fortifying" and helped to maintain attention and focus. This lent itself to students developing a rapid understanding of nutrition, and inspired students to apply the concepts learned, both to their own nutrition and to patient–physician interactions. As mentioned above, the students were also asked to build a nutritional and economically balanced meal using resources provided in the presentation. After each group presented the meal that they had built, students discussed the importance of understanding how to build nutritionally balanced meals that are economically feasible, especially in food desert areas, such as ours. As seen from Table 3, one individual described feeling better prepared to meet nutritional goals according to various financial needs, both on a personal basis for his or her own nutrition and to accommodate patient concerns in a clinical setting.

The qualities of learning from peers, thinking analytically and applying newly learned concepts are all unique to the active learning model. A single constructive criticism was received addressing the dense nature of the material, which could be simply accounted for in future activities and is a caveat nonspecific for this style of education.

3.3. Exploratory Factor Analysis of the Survey Questions

The survey questions were designed to gauge how the workshop objectives were achieved. Cronbach alpha (0.276) confirmed that there was more than a single theme contained in the questions. Cronbach alpha indicates the extent of internal consistency among different questions.

To further distinguish between themes, an exploratory factor analysis was performed. This statistical test described the relationship between the four questions identified above. Specifically, the different variables or questions were assumed, under this procedure, to represent latent variables or themes that combine elements of the different questions. The test stratifies factors in order to understand the order or structure among the variables measured. In this analysis, Factor 1 indicated that both question 1 ("informative") and question 2 ("think about nutrition") were related, and defined themes that were separate from questions 3 ("nutrition to diseases") and 4 ("enjoyed peer interaction"), thereby corresponding with the strongest indications by any factors. Factor 2 indicated the definition of theme between questions 2 and 3, while factor 3 showed that questions 1, 3, and 4 defined a separate theme. As factor 1 rendered the highest coefficient, it indicated that those relationships were more significantly associated in relation to their theoretical structures, such as common causes that explained the outcome of the analysis. Results of the exploratory factor analysis performed with a rotated factor pattern are shown in Table 4. Questions 1–4 represent the objectives mentioned above: (1) Acquire basic clinical knowledge and skills, (2) Gain a better understanding of nutrition, (3) Formulate a linkage between clinical nutrition and disease, and (4) Experience and benefit from peer interaction. Results determined the most significant theoretical associations to be described by Factor 1, indicating strong ties between Q1 and Q2 together, in comparison to Q3 and Q4.

Table 4. Exploratory factor analysis performed with a rotated factor pattern.

Question	Factor 1	Factor 2	Factor 3
Q1	0.07764	0.98545	−0.04447
Q2	0.04992	−0.04296	0.99601
Q3	0.84271	−0.05736	−0.00879
Q4	0.77404	0.18155	0.08119

As seen above, the concepts were further reinforced by the exploratory factor analysis, in which Factor 1 indicated the strongest relationships between the questions "Did you acquire basic clinical knowledge?" with "Did you gain a better understanding of nutrition?" as compared to the other questions in the survey. This relationship points to the idea that the understanding of nutrition and its pathophysiology was closely tied to the acquisition of basic clinical knowledge, indicating that students were able to take the information that they were presented with and translate it into concrete clinical comprehension. This relationship is one that bears great importance in the education of all students; conveying the practical uses of theoretical knowledge not only is shown to help students retain the information, it simultaneously prepares them for future applications in their careers [39]. Ultimately, the concept of future preparedness is reinforced with the so-called "soft skills" that students develop in active learning settings. Analytical thinking, communication skills, flexibility and adaptability, therefore, remain an important keystone of professional functioning, and are vital to foster in an educational setting.

Following exploratory factor analysis, the Kaiser-Meyer-Olkin (KMO) Test was utilized to ensure that data was suitable for Factor Analysis. The KMO value was 0.5335, validating that sampling adequacy was met, as 0.050 is considered the minimum for sampling adequacy. Next, Bartlett's Test for Sphericity was utilized to rule out any homogeneity of variance. The resulting value was $p = 0.5625$ and was not significant. Next, the Eigenvalue or total variance explained by each factor were calculated; factors less than 1 were considered to have subpar total variance to represent a unique factor. This resulted in 3 factors being retained, as seen from Table 5.

Table 5. Eigenvalues to determine magnitude of results.

	Eigenvalue	Difference	Proportion	Cumulative
1	1.40165113	0.33047320	0.3504	0.3504
2	1.07117793	0.21629217	0.2678	0.6182
3	0.85488576	0.18260058	0.2137	0.8319
4	0.67228518		0.1681	1.0000

3.4. Applicability of the Workshop

Ultimately, it is evident that active learning optimized engagement and understanding in the context of teaching nutrition and community health. Utilizing the active learning approach in the program for college undergraduates interested in healthcare allowed for the faculty to create an engaging environment for students to learn about topics, such as biochemistry, nutrition, and public health. By providing context, and allowing students to develop their own answers to current matters, the session simultaneously illustrated the issues facing the underprivileged community through a scientific lens.

By understanding new information and its uses, individuals are better prepared to apply topics that they have only recently been exposed to. For example, students in this session reported reflecting on their own nutrition habits, building meal plans with a healthy distribution of macro-and micro-nutrients and understanding various nutritional deficiencies, as well as the role of financial struggles in patient accessibility to self-care. The performance in the post-quiz, as compared to the base level knowledge, demonstrated by the pre-quiz, suggested that students understood the newly taught material well and were able to apply it to clinical scenarios.

3.5. Benefits and Limitations

There are various types of group-based active learning sessions reported in literature, for example, jigsaw [40], Patient Oriented Problem Solving (POPS) [41–43] and Team-Based Learning (TBL) [44,45]. These pedagogical modalities have advantages, for example, they strongly depend on team work, as well as individual contributions, to achieve optimal outcomes. Some of these activities involve peer teaching, which, in turn, plays an important

role in enhancing knowledge acquisition and comprehension. Depending on how they are structured, these activities may need preparation from the students prior to the session, resources, such as multiple rooms and faculty supervisors, etc. Our nutrition workshop, described here, was dependent on teamwork and also involved peer teaching. However, it did not require the students to prepare prior to the session. As the students worked in groups, it reduced stress. The students were engaged in peer-teaching and participated in thoughtful discussions with their group. This helped in developing communication skills. The workshop was also high yield with respect to time; a number of diseases/disorders were discussed in a time-efficient manner. The workshop gave the students the opportunity to think critically about nutrition in the context of a disease. The better student performance in the post-quiz supported the notion that the students carried out thoughtful discussions. The complexity of the materials was carefully designed to avoid the need for excessive guidance during the session. The workshop was carried out in a single room with a single faculty presenter. This study had certain limitations. This workshop was specifically designed for the summer pipeline program. Thus, the only participants were the students enrolled in the pipeline program. This resulted in a small sample size. There was no specific enrollment of participants. As this workshop was a mandatory activity, it was not feasible to have a control group. As this workshop was carried out for students from a summer program, we were not able to ascertain data points to support the long-term retention of active learning. In future studies, it would be beneficial to attempt to implement this program for students from various academic fields and socioeconomic statuses, to explore more in depth the different adaptations of active learning that could be used in these settings. Utilizing participants from varied groups, such as K-12 students, nontraditional students, and various graduate programs, could also indicate the efficacy of different active learning techniques by each group.

4. Conclusions

Using the program workshop as a microcosm for education as a whole, it can be extrapolated that this type of workshop can be created and applied for any academic discipline, including basic sciences, humanities, and liberal arts. The learning technique functions to help learners amass new knowledge while simultaneously solidifying previously learned concepts, resulting in heightened understanding of academic material. For example, part of this exercise was to leave students with a brief understanding of the economic challenges associated with assembling nutritious meals. If we had wanted to engage students in understanding more about the challenges patients face in terms of food accessibility, we could have had students brainstorm various issues barring access; such a discussion could lend itself well to various humanities disciplines. Thus, although this workshop was mainly focused on the biochemical elements of nutrition, it can be deduced that it would still maintain its efficacy in other educational settings. Future direction will include designing similar workshops for other subject disciplines.

The results of our study demonstrated that active learning is a valuable technique for educators. It empowers students to approach learning in an engaged manner that optimizes knowledge retention and contextualization. This model of education allows students to efficiently acquire and analyze information, a skill that is necessary to successfully progress, both within academia and professional environments. The study demonstrated that, in a group of undergraduate students with similar career aspirations, active learning techniques can be utilized to captivate students to learn new information. In addition, we demonstrated that active learning allows for the incorporation of prior experiences and expertise of both instructors and fellow students to further weave a fabric of knowledge that students can continuously add to for the entirety of their academic careers. To further our understanding of active learning and make a substantial impact on education, research must be performed to examine the long-term effects that this model can have on students. Furthermore, we must account for the transferable, or "soft skills," method of education that it may instill in students, such as analytical thinking, debating and communication

skills, concept-mapping, and fostering curiosity for future learning. Overall, active learning holds great potential to teach the promising minds of the next generation.

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