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USING LABORATORY EXPERIENCES WITH JOURNAL WRITING
TO TEACH A NUTRITIONAL UNIT TO 7th GRADE STUDENTS

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Heather Ann Bradway

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USING LABORATORY EXPERIENCES WITH JOURNAL WRITING TO TEACH A NUTRITIONAL UNIT TO 7TH GRADE STUDENTS

By

Heather Ann Bradway

A THESIS

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ABSTRACT

USING LABORATORY EXPERIENCES WITH JOURNAL WRITING TO TEACH A NUTRITION UNIT TO 7TH GRADE STUDENTS

By

Heather Ann Bradway

This project was designed to study the effectiveness of innovative instructional materials created for a middle school health science classroom. Students were provided the opportunity to learn about nutritional concepts using constructivist methods. The goals of this unit were that students would: 1.) recognize the different nutrient components of food; 2.) establish the relationship between good nutrition and a healthy body; 3.) interpret food labels using their nutritional understanding; and 4.) construct their own knowledge about nutrition through laboratory experiences. The amount of understanding about nutrition between two classes of students was compared. In one class, laboratory activities with traditional lectures were employed. The other class constructed knowledge by using journal writings in conjunction with the laboratory investigations. Students engaged in both writing and lab experiences demonstrated a higher level of understanding of the concepts taught in the unit as indicated by pre and post test score comparison and in the journal reflection and response questions.

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INTRODUCTION

I. Rationale for Study

As a middle school science teacher, I am challenged primarily in two ways. The first challenge comes from my students. I need to maintain their interest, help them develop their critical thinking skills, and encourage them to ask questions about the world around them. The second challenge comes from myself, in striving to understand more about a given content area and also in developing more efficient ways to help my students master a particular concept. Being offered the opportunity to instruct a nine-week health course for seventh graders gave me the chance to develop a unit with which I hoped to meet and exceed these challenges from my students and for myself.

Within the arena of health education, I chose to develop a unit on nutrition. I found the subject of nutrition boring and monotonous because of my prior experiences of memorizing the functions of vitamins and minerals and doing meaningless calculations with food labels. I knew that if I could find ways of making nutrition interesting to me, I could make learning about nutrition fun for my students.

A nine-week health course with a unit on nutrition taught four times throughout the school year to different groups of students can lend itself to scientific study. To develop new teaching strategies, and then implement, adapt, and assess these strategies over time could be accomplished with a course which was repeated throughout a school year more easily than a unit which was taught only once during the year.

Another reason for this study was to prove to myself the validity of constructivist learning through the use of laboratory investigations. I had been introduced to this method of teaching during my undergraduate studies. However, it had not been until after five years of teaching and the course work at Michigan State University that I could implement this teaching method with any degree of confidence. I had read about constructivism; now it was time to put constructivist methods to the test.

The learning goals of this unit were that students would:
1.) recognize the different nutrient components of food;
2.) establish the relationship between good nutrition and a healthy body; 3.) interpret food labels using their nutritional understanding; and 4.) construct their own knowledge about nutrition through laboratory experiences.

II. Changing the Nature of My Laboratory Instruction

In my previous five years of teaching, the textbook led the direction of my teaching, and subsequently, the learning experiences of my students. I used laboratory activities. However, it was apparent that my students were not connecting what was happening during the activity to what was being discussed in class, i.e., students did not understand the purpose behind the laboratory activities. Additionally, I was concerned because students rarely asked if they could experiment on their own. I wanted my students to engage in the activities with curiosity and take an active part in what they were trying to discover with a sense of personal satisfaction.

My old strategy of using laboratory investigations was similar to following a carefully laid out recipe. Students were given a lengthy introduction. Next, they made a mad dash to complete the cookbook style activity before the end of the period. Following this, students were expected to write a lab report with five distinct sections.

Within this lab report, students wrote out the "introduction" section and the procedural section which was termed "method and materials". Both of these sections could be copied easily from the information provided in the lab handout. Students had to design a table or graph, which comprised the "results" section. This section depicted the data that students had collected from the laboratory activity. Additionally, in the lab report, students had to answer questions in a "discussion" section. Finally, they wrote a brief statement summarizing what they learned from the laboratory activity in the "conclusion" section. I now see that there are flaws with this layout. The following paragraphs describe my observations regarding this method of laboratory instruction.

When completing a lab activity in this manner, I had no way of determining the prior knowledge of a student. Also, much of the writing was more like following a structured plan, the lab report, rather than a means to explore and understand the relationships between given ideas.

Since I also felt a sense of urgency to cover as many concepts as I could to ensure that my students were getting the "best" education, many activities ended up being rushed. This was especially true during my first two of years of teaching. I would push my students and myself to complete the laboratory activity within one fifty-minute class period, all so that I could move on to the next section of the textbook. Bob Tierney (1996) wrote that the average high school text introduces seven to ten new concepts per page and it was determined that a teacher wishing to cover an entire textbook must introduce a new concept every two minutes. Applying this statement to what I did in the past would imply that very few of my students had the necessary time to process the given laboratory exercise and incorporate it into their schema of understanding. Rushing through laboratory activities without knowing the prior knowledge of my students and to proceed through content believing that more was better did not provide my students with the best learning opportunities. Students may have felt frustration in trying to connect what they understood to what they were experiencing in class.

Endeavoring to be the best educator that I could be, it had become apparent that I needed to learn the constructivist approach in teaching laboratory activities. Rather than directing my students' learning, I chose to develop my abilities to guide student construction of understanding nutritional science. If students are to achieve constructivist learning, I must employ constructivist teaching (Appleton 1997). According to Patricia Stohr-Hunt (1996), my role as a teacher must change from a knowledge giver to one which will allow students to construct their own knowledge through meaningful experiences.

The rest of this section is my interpretation of this teaching method, and how it can be used to enhance learning during laboratory work and investigations.

III. Maximizing the Learning Potential of Laboratory Experiences

When employing laboratory exercises as a means to facilitate student understanding of a concept, the teacher must be careful not to simply present a laboratory situation and expect students to gain from it what the teacher desires. Constructivism is more than leaving the student to "discover" the truth because many times a student will formulate an understanding but not the one that a teacher had intended (Driver 1983). It is important to consider that everyone constructs meaning from an experience. However, the meaning is based on earlier formed beliefs (Rutherford and Ahlgren 1990). This is when a misconception can be formed and sustained if a teacher does not know what students believe to be true. A misconception or alternative framework can interfere with the understanding of a student regarding a specific science activity and can have a wider range of implications for understanding science in general (Driver 1983).

Given that my old style of laboratory investigations did not make use of identifying student misconceptions, the first change I made was to include pre-lab activities which involved reflection questions. My intentions with these questions were two-fold. The first was to determine where my students' understandings were with a given concept. Effective teaching begins with knowing students' viewpoints about a concept (Pope and Gilbert 1983). Once I knew what my students knew and believed about a particular idea, I could use their current level of understanding to increase their knowledge about science concepts. This could be accomplished by creating experiences which were meaningful and lead to further student reflection and the formation of new theories about nutritional science (Ward, et al. 1996; Pope and Gilbert 1983).

The second function of the reflection questions was to generate student motivation through curiosity and conflict. I was purposefully creating a level of cognitive appeal. Cognitive appeal is directly related to differing levels of curiosity, everything from sensory experiences to discrepant situations or events (Martinez and Haertel 1991). If students become curious about how something affects the body, or why a particular solution changes color, they will want to discover the "how" or "why" using experimentation. This is especially the case when the questions are crafted in relation to their own life experiences with food and nutrition. Also, if a particular question created opposing ideas in the minds of students, it was my intention that the lab exercise became a way for students to seek an answer (Rutherford and Ahlgren 1990). Purposeful learning requires purposeful teaching with specific learning objectives on the part of the instructor: "Everything that a person does is shaped by intentions and learning events must be seen as intentional" (Wheatley, 1991, p. 13). Also with the introduction of purposeful conflicts created by reflection-based writings, students are forced to examine their misconceptions and hopefully reorganize their ideas about the world (Wheatley 1991).

Early on in my study, I required students to keep a folder, which contained all of their lab reports, written responses to questions, and tests. I soon found out that this was not a reliable means to maintain student data. For accurate documentation of data, I found that having students record their lab reflection questions and subsequent lab analysis questions in a notebook, which was termed a "Health Journal", a much better choice. Additionally, the notebook served as a tool of assessment and as a catalyst for the construction of student knowledge (Pierce 1998). The notebook served as a point of discussion, both in pre and post laboratory investigations. This discussion was necessary for students to construct new knowledge (Tamir 1989). Having my students write so much more was a major change from my usual style of instruction. Previously, all classroom activities had incorporated writing as a tool to show that learning had occurred such as the writing of a traditional lab report following the completion of a laboratory investigation. The constructivist model challenged me to use writing as a tool for student learning (Ogens 1996). This type of writing allowed my students to make predictions about outcomes, and to construct new knowledge through a hands-on experience about food and nutrition. Writing, whether reflective or in application, provides students with the process to look back on what they know, integrate old with new ideas, and to ask further questions about what they now understand with classroom dialogue either with peers or with the teacher (Fellows 1994). Simply put, writing allows students to think (Ogens 1996).

Ultimately, my goal was to use laboratory exercises as the center of my students' construction of knowledge instead of lecture notes. Many of the books and journals that I read were helpful in demonstrating the usefulness of the constructivist model. However, I needed a practical example of how to turn my laboratory activities into the necessary link between what students knew and the intended learning outcome. In the article, "Linking Learning to Labs", by Wendy Pierce in the January 1998, <u>Science Scope</u>, a template for creating laboratory activities based on constructivist learning was modeled. Pierce wrote of using reflective writing, simple guidelines during the actual laboratory activity, student discussions of what they observed, some direct teaching, and finally a set of application and analysis questions to be answered by the student. I used this basic model in the work described in this paper.

Another change that I incorporated was in the conclusion statement typically found at the end of my students' lab reports. Bob Tierney (1996) had his students write a conclusion with the following items in mind: 1) the best response to the original question; 2) a reason for the response; and 3) any questions that remain regarding the activity. I had my students write a conclusion using the criteria described above instead of simply addressing the question, "What did you learn by completing the laboratory investigation?".

This format was different from what I had been using. I had to rewrite, and in some ways simplify, all of the labs that I originally thought were adequate. I developed reflective writing sections in the students laboratory investigations. Leonard Rivard (1994) wrote that reflective writing is a tool for restructuring knowledge. I wanted my students to examine what they understood and to reevaluate what they believed to be true about a concept. If this was to occur, questions needed to be designed which would allow for deeper connections between prior knowledge and what students were observing during an experiment.

I also simplified the laboratory activities. Since my intention was to have students complete the laboratory activity **before** any formal instruction on a topic, I needed to shorten and clarify the necessary protocols in the investigations. I did not want my students to become frustrated with calculations, with unfamiliar chemical equations, or a complicated list of instructions. Instead, I wanted to give them the liberty to explore and to form connections with the newly presented ideas without being hindered by processes which were not relevant to their learning of concepts of nutrition (Pierce 1998).

Students start to actively engage in the material when they become involved in developing an experiment of their own (Emery 1996). Having students do this would be a big change from my previous attempts to implement labs and earlier trials of this nutrition unit! The focus changed from students simply finishing the lab, to having the laboratory activity become a personal experience in constructing knowledge about food.

All of the previously discussed methods are in line with the constructivist model of using hands-on activities including laboratory investigations to improve student learning and teacher instruction. As Emery (1996, p.18) wrote:

> The constructivist approach allows students to "construct" ideas and develop concepts one step at a time. Students discover their misconceptions and, through a hands-on approach, replace those misconceptions with truths. It is this rebuilding of their mental pictures and framework of concepts that keeps students so engaged in learning that they forget to be uninterested in the subject.

I want my science class to be one where students become curious, ask questions and are willing to search for the answers. Science should be a process which allows students to gain new information (Rutherford and Ahlgren 1990). With the implementation of this unit, a shift in my instruction has occurred. Of course, it may take a while before I become completely comfortable with this method of teaching. However, I believe that my students and I will reap the rewards of using the laboratory while creating personal experiences through constructivist learning and this work provides data that supports this belief.

IV. Demographics

I teach in a rural district in which the closest city has a population of about seven thousand. The district is approximately ninety miles from a city with a population greater than twenty thousand. There are roughly 1,000 students, of which over 98 percent are Caucasian. The middle school has approximately two hundred and eighty total students in grades six, seven, and eight. This study is based on a nutrition unit which I designed for a health science class. The class is for seventh grade students and it falls into the exploratory, or as we call it, "encore", category since it is nine weeks long as compared to eighteen weeks for a semester course. Students rotate throughout the year, every nine weeks, with a new encore class. Students have three encore classes a day in addition to their four core (math, geography, science, and language arts) classes. I taught the health class four times throughout the school year for fifty minutes a day, which can make laboratory activities difficult to run. Of the forty-five students split among two classes who participated in this study, thirty were male and fifteen were female. Forty-four were Caucasian and one was of African-American descent. Two of my students were receiving services from the special education department.

V. Scientific Background

Understanding human nutrition begins with knowing the difference between the term nutrient and nutrition. A nutrient is anything which the body needs to grow and is necessary for the life processes. Nutrition is the scientific study of how food affects the overall health of the body. One may be confused with the difference between food and nutrients. However, it is the quantity of nutrients within the food that makes it nutritious. There are six categories of molecules that compose the nutrients, including carbohydrates, fats, proteins, vitamins, minerals, and water. The first nutrients discussed in class were carbohydrates, commonly known as sugars.

There are two types of carbohydrates. Some are termed complex and some are termed simple. Complex carbohydrates are composed of long chains of glucose as well as other monosaccharides bonded together to form a polysaccharide. Examples of complex carbohydrates include starches and plant fibers. Simple carbohydrates are composed of one or two sugar molecules. These monosaccharides include glucose, galactose, and fructose. The other simple carbohydrates called disaccharides are composed of two monosaccharides bonded together to form the sugars such as sucrose, maltose, and lactose.

The primary function of carbohydrates in the body is to serve as a source of energy. When the body uses various enzymes to digest sugars, all are converted into the monosaccharide, glucose, also known as blood sugar. Interestingly, the most popular food additive in the United States is sucrose. According to Jane Brody (1988), people in 1988 consumed an average of 128 pounds of sugar each in a single year as compared with Americans a hundred years prior who ate about forty pounds per year. Consuming too much carbohydrate can lead to problems such as obesity, hypoglycemia, and hyperglycemia.

The next nutrient explored in this unit was protein. Proteins are macromolecules, often composed of between one hundred and five hundred amino acids in length. Of the twenty amino acids, eight are termed essential. This means that the human body cannot manufacture them internally, and it must find an external source through the foods consumed. Proteins can come from both plant and animal sources. The functions of proteins in the body are numerous. They do everything from building tissue and replacing cells to performing specific enzymatic reactions within the body. Protein can also be used as a source of energy for the body however, carbohydrates are more efficiently converted for this purpose. Eating too much protein can lead to kidney damage, losing calcium, and increasing body fat.

In this unit, the necessity of fats was explored as well as the problems associated with a high fat diet. Fats can be divided into two types: saturated and unsaturated. Saturated fats contain all of the hydrogen atoms that fat molecules can possible hold. Saturated fats are solid at room temperature. Unsaturated fats contain some double bonds between the adjacent carbon atoms and do not hold as many hydrogen atoms as saturated fats. Unsaturated fats are a liquid at room temperature and are generally considered to be oil.

Fats do not simply move about the bloodstream. They must be prepackaged within an envelope called a lipoprotein. A high-density lipoprotein or HDL contains more protein than fat and is then "less sticky" in the artery than its counterpart, the LDL or low density lipoprotein. Conversely, a LDL contains more fat than protein and is more sticky in the bloodstream. Too much fat in a diet can cause problems beyond the expected obesity. If the majority of a person's diet consists of foods high in saturated fats, high levels of LDL in the blood can result. In addition to increased LDL, high levels of cholesterol, a molecule found only in animal fats, can increase the chances of developing atherosclerosis. This starts a domino effect which can lead to high blood pressure and to a heart attack or stroke. Fats do serve a useful purpose in the body. They act as an insulator under the skin and as adipose tissue surrounding organs. Additionally, fats are necessary for hormone production as well as for the absorption of the fat-soluble vitamins, A, D, E, and K.

Another pair of nutrients discussed was vitamins and minerals. Vitamins are complex, organic molecules which help in various chemical reactions throughout the body. Vitamins are divided into two categories based on solubility. They can be either fat-soluble, such as the vitamins A, D, E, and K mentioned earlier, or they can be water-soluble. A few commonly known water-soluble vitamins include vitamin C, the B complex vitamins, and biotin. Minerals are inorganic but also perform a wide range of vital functions in the body. Minerals are considered to be macro or micro in nature depending on how much is required by the human body. The best way to get the daily requirement of essential minerals and vitamin is through the foods eaten. Various diseases and complications can result if the proper amounts of each are not consumed.

The final and most vital nutrient is water since the body can only survive three to five days without it. People should drink at least six 8 ounce size glasses of water daily. Even if someone does not directly consume this amount of water, they can obtain it from the ingested foods. One such example is green beans, as they contain eighty-nine percent water.

After developing an understanding of what nutrients are and how they differ from food, one can explore how nutrients influence the nutritional value of a food. The greater the variety of nutrients found within a food, the more nutritious the food. This is especially true if the food has not been processed or refined and is low in calories. Of course, more of a nutrient is not always better, as is the case with the presence of sodium or saturated fats.

In addition to nutrients and nutrition, the concept of energy or calories stored within some of these nutrients should not be ignored. There are differing amounts of calories in the various nutrients and foods. The term calorie is defined as the amount of heat required to raise the temperature of one gram of water one degree Celsius. This energy can be measured from food by using a device called a calorimeter. This device allows a given amount of food to be burned. A given amount of water is situated above the burning food item. As the food is burned, the heat generated raises the temperature of the water. It is possible to calculate the amount of energy released as calories as a result of burning the given amount of food. Both carbohydrates and proteins release four kilocalories or 4000 calories with every gram burned. Fat releases nine kilocalories per gram burned. Understanding the relationship between nutrients, food, and caloric value is important in being able to decipher food labels and deciding which foods to consume on a daily basis.

Being able to make informed decisions about which foods to eat is important; however, another nutritional concern is understanding the relationship between the types of nutrients consumed and their effect on a person's health. One such cause and effect relationship is adult-onset diabetes mellitus and the presence of glucose and ketones in the urine.

Type II diabetes or adult onset diabetes results from an absence or inactivity of insulin in the blood. Insulin, a protein released from the pancreas, helps glucose enter cells throughout the body. A problem with insulin can lead to excess or high blood sugar which can be measured in the urine. Excess glucose is converted into fat. Fat can clog arteries, leading to high blood pressure and to heart problems. Other problems resulting from complications with type II diabetes include kidney damage, retinal damage, skin and urinary infection, and ketosis. Ketosis occurs when fats are used for energy instead of carbohydrates. When a person has type II diabetes, the body is unable to use glucose and the excess ketones, which are measurable in urine, can make the blood acidic and poison the brain.

Adults can get this type of diabetes from years of poor eating habits, including the over consumption of foods containing refined sugar and flour. In addition, a lack of regular exercise can contribute to the inactivity of insulin. Heredity also plays an important part in the development of this disease which kills at least one thousand Americans every day.

There are many diseases that can be studied in order to understand the connections between nutritional choices and health. Type II diabetes serves as an easy model to examine for this purpose. A complete list of the resources I used in gathering this scientific information and designing the activities can be found in Appendix A.

IMPLEMENTATION OF THE UNIT

I. Overview

Since I have taught this unit four times during the period of the past year's research, the method of delivery evolved as I implemented more of the constructivist style in teaching laboratory activities. At the beginning of the school year, during the initial implementation of this unit, I used a student survey and a series of pretests as a means to identify student misconceptions. In later iterations, I made use of student journals in addition to the survey and the pretests. I found that I was better able to facilitate a laboratory experience if students had questions in mind and a sense of personal purpose before attempting the lab. This was done by incorporating a series of reflection questions prior to doing the laboratory activity. These questions required students to write and think over what they knew about the given topic. Students would then embark on a mission of investigation instead of simply doing what I told them to do in order to get a good grade (Smith 1990).

For purposes of completing this study, two classes of students were compared. The first class studied came from the second iteration and was termed, "A". With this class I implemented the newly developed laboratory activities. The second class studied was termed, "B" and came from the third iteration. The students in

Class B were provided with constructivist learning opportunities in addition to the laboratory activities.

Students in group B were provided with a spiral bound notebook at the beginning of the unit. Within the notebook, termed the "Health Journal," the reflection questions were answered in complete sentences. It involved some extra work for me; however, it was absolutely necessary that I review the answers to the reflection questions prior to the completion of the labs. Questions were not graded for content but only for effort and completeness of thought.

In addition to engaging the student as observed in their journals, the reflection questions provided a means to identify student misconceptions, allowing for the appropriate adjustments of a given laboratory activity. After spending a class period writing and discussing reflection questions with peers and me, the students would engage in the laboratory investigations.

All of the laboratory exercises were developed as a result of my coursework and research at Michigan State University (Summer 1999). Each activity was designed with the intention of engaging students and helping them develop a deeper level of understanding of various nutritional concepts. Additionally, students in group B were given no lecture notes prior to the labs. My purpose in omitting lecture notes was to facilitate student understanding as a result of the experience with the lab rather than through direct instruction using lecture notes.

To complete the laboratory exercises, students would work in groups of two to four. Students were required to record all results in the form of tables or charts within their journals. The time taken to complete laboratory investigations was not an issue. If three class periods were needed to do the lab then three periods were used.

Once the lab was completed, the students and I would discuss the results. This was done because, in many instances, different student groups did different parts of the investigation, and the class needed the data to obtain the "big picture". Students were also encouraged to share their insights about what they had learned as a result of completing the lab. Additionally, class discussions were used to explain any chemical processes or terms which may have caused confusion. Students were instructed to wait until after the class discussion to complete the next section of the laboratory experience, which included the journal response questions and the statement of conclusion.

The final stage of the laboratory experience consisted of two parts. The first was journal response questions to be written in the health journal of each student. The purpose of these questions was to determine student understanding at the application and synthesis levels. During the second part, students were required to write a statement of conclusion regarding the laboratory investigation. Within the conclusion, students were to express the answer to the question provided at the beginning of the laboratory activity (often found in the title of the activity), and then to explain why they formed a given answer. The responses written by students were graded for content and their ability to explain answers, citing examples from the lab experiences. Journal response questions and the conclusion statements were graded immediately following the laboratory investigation.

Additionally, students were to write any questions about the activities that were still unanswered. This provided an added assessment regarding the success of the laboratory design. The structure of the laboratory activities can be condensed as: 1). reflection; 2). action; 3). results; 4). direct teaching; 5). journal response writing; and 6). conclusion statement.

After the entire laboratory experience was completed, I provided remaining critical information in the form of notes on the given concept to the students. Following the notes, the students once again began a series of reflection questions for the next lab and the entire process would continue. After a series of laboratory investigations and notes, with each lab focusing on no more than two to three concepts, tests were given to measure student learning.

Three sets of pre and post tests were administered (Appendix B). The first pre and post test focused on carbohydrates, proteins, and fats. The second tests focused on water, vitamins, and minerals, in addition to additives and preservatives. The final set of pre and post tests assessed student understanding of calories and the effects of nutrition on the health of individuals.

Many new teaching techniques were developed as a result of my research project. They can be summarized as: 1.) journal writing; 2.) reflection questions and a defined conclusion statement within the laboratory write-up; 3.) increased student discussion prior to completion of the lab; 4.) completion of labs prior to lecture; and 5.) increased time for completing learning activities.

II. Basic Outline

This unit on nutrition required five weeks of instructional time. All of the activities are new and are the result of my coursework and research at Michigan State University (Summer 1999). A complete copy of each laboratory investigation and activity can be found in Appendix C. The numbers in parenthesis after each activity represent the objectives addressed, which can be found on the following page.

A. NUTRIENTS FOUND WITHIN FOOD

1. Carbohydrates and Proteins (1, 2, 4)
2. Sugars in Cereals (3)
3. Vitamin C in Juices(1, 3, 4, 5)
4. Lactose in Milk (1, 4, 5, 8)
5. Using a Hydrometer in Liquids (4, 5)
6. Fats, Proteins, and Carbohydrates in Liquids (1, 2, 3, 4, 5)

B. DISEASES, NUTRITIONAL CHOICES, AND HEALTH

1. Glucose, Ketone, and Protein Determination Through Urinalysis (1, 3, 4, 5, 7)

C. CALORIES AND THE NUTRITIONAL VALUE OF FOOD

1. Nutritional Label Analysis of Various Drinks (3, 5)
2. Calorimetry Demonstration (6, 7)
3. Food Label Analysis (3, 6, 7)

D. ASSESSMENT

1. Journal Response Questions and Conclusion Statement
2. Pre and Post Tests
3. Surveys

III. Unit Objectives

All of the following objectives were taken from the Michigan Essential Goals and Objectives for Science Education (MEGOSE). These objectives consist of constructing, reflecting, and using scientific knowledge to implement instruction and to assess student learning. The New Directions teaching unit called Food, Energy and Growth, which was produced by the State of Michigan (1992), also helped to organize my nutrition unit in terms of objectives.

1. Generate scientific questions about the world based on observation.
2. Design and conduct simple investigations.
3. Use sources of information to help solve problems.
4. Write and follow procedures in the form of step-by-step instructions, recipes, formulas, flow diagrams, and sketches.
5. Evaluate the strengths and weaknesses of claims, arguments, or data.
6. Explain how cells use food as a source of energy.
7. Compare and contrast food, energy, and environmental needs of selected organisms.
8. Explain how cells use food to grow.

IV. Evaluation Protocols

In determining the overall effectiveness of this unit there were three levels of assessment. The first level was the pre and post test scores for those forty-five students who participated in this study. There were three separate pre and post tests throughout the unit (Appendix B). They consisted entirely of constructed response questions, since it was important that student understanding could be accurately assessed. Nothing could be left to chance as would be the case in a multiple-choice style test where students can guess.

The second level of assessment was the journal response questions and the conclusion statements. The written response questions were designed to measure the effectiveness of the laboratory experience in terms of implementation and increased student understanding. The conclusion statement required each student to write about any further questions that she or he had regarding the laboratory activity.

In evaluating the individual activities I examined the journal work of six students, two high-achieving, two average, and two low-achieving students from Class B. The achievement level was based on their first semester standings in their "core" classes (math, geography, science and language arts). The high achieving students both earned all A's in the first semester, the average students earned a combination of B's, and C's, and the low achieving students earned D's. It was necessary to rate achievement in this manner since Health science is an "encore" class, and I do not have these seventh grade students in the core science classes. I have these seventh grade students for a period of nine weeks before the next rotation of encore classes begins.

To evaluate student attitudes on the different laboratory activities and on the different modes of implementation, I conducted surveys of all students in classes A and B before and after the unit's implementation. This survey can be found in Appendix D.

V. Laboratory Investigations: Description and Analysis

Appendix location of each activity is in parenthesis.

Activity: Which Nutrients Do Foods Contain? (C1)

The purpose of the first laboratory investigation was to have students observe the presence of various nutrients within food. These were proteins, simple carbohydrates (glucose), and complex carbohydrates (starch). Students used Biurets reagent to indicate the presence of protein, glucose strips for glucose, and Lugols solution for starch. Some of the foods tested were in solution while other samples remained as they would be found in a grocery store. The journal response questions were designed so that students would have to think about which nutrients might be found within a given food item. The student responses to these questions revealed a single misconception. Three of the six target students were confused about the definition of a nutrient. They wrote that nutrients found in foods included items such as caffeine and wheat. All six students appeared to understand that it was possible for a food to contain more than one nutrient since they had read nutrition facts or labels on cereal boxes or on a milk cartons. While completing the laboratory investigation, students were allowed to choose five food items to test. If they brought an item from home, they could test it for the various nutrients with my permission. Students were broken into groups of four, and each group was assigned to test for a specific nutrient. Each group was also responsible to test a “mystery food” for nutrient content. The use of an indicator seemed to generate interest and it appeared they were familiar with its purpose. After completing the lab and filling in the charts with the data that their group had collected, a class discussion followed. Each group shared their results and we filled in the entire chart for all of the food items available. There was some confusion as to a positive or negative result with a given indicator. Color interpretations can be subjective for students unfamiliar with the use of indicators. I can tell them that a certain color means positive or negative, but until they experience it for themselves, they simply are unsure how to interpret the results of the indicator tests.

Their journal response questions revealed that learning had occurred. Students demonstrated that they could name the nutrients that comprised the foods they tested. Additionally, all six students could explain the importance of using an indicator to complete the laboratory investigation. They were also able to infer that if a food did not react positively for any nutrients that this did not necessarily mean that it was void of any nutrients.

The problem of color interpretation with the indicators used became apparent on the post test results. Two of the six students wrote that foods like apples and onions were high in protein. All six students were able to state that bread or cereal were foods that were high in carbohydrates. Additionally they were all able to write about how foods contain more than one nutrient with five of the six students using examples from their laboratory experience. The last question on the test asked students how they would determine the nutrient components of a mystery liquid. Five of the six were able to describe an experiment using indicators to identify nutrients within the mystery food.

Demonstration – Sugars in Various Foods

The next demonstration-style activity was intended to generate interest of sugar content in prepared foods. Students were shown a two-liter bottle of Mountain Dew® pop. I took out some granulated sugar and asked them to guess how much sugar was equivalent to the amount found in the two-liter bottle. This led to some interesting discussion; however, for the most part, students guessed low on the amount of sugar. They were very surprised when I showed them that a two-liter of Mountain Dew® contains sixty-eight teaspoons of sugar! Immediately after this demonstration, students were given a copy of a list from Jane Brody's Nutrition Book, of popular breakfast cereals showing the percentage of sugar found within one serving of the cereal. Students were then instructed to look up their favorite cereals and find out what percentage was sugar. This activity certainly generated interest and many students took the list home to show their parents.

Lab: Vitamin C – Do You See It? (C2)

The next laboratory investigation was designed to allow students to test for the presence of vitamin C in various drinks including orange juice, Mountain Dew®, Powerade®, Sunny Delight®, and the juice from a pepper. The objective of the lab was two-fold. The first was to give students the opportunity to determine nutritional value of the drinks they consume in terms of vitamin C. The second was to find out whether or not the preparation of a drink affected its vitamin C content. Out of all of the laboratory investigations modified, this one was changed the most. The original lab included calculations to determine exactly how much vitamin C was within a given sample. The calculations involved basic algebra. However, after implementing this lab a couple of times, I found that students did not have the prerequisite math skills. I dropped the calculations starting with the third iteration of this activity.

One of the reflection questions asked students to rank the above mentioned drinks in terms of highest to lowest in vitamin C content. The reflection questions indicated that advertising has influenced what students think about the nutritional content of food. Five of the six target students thought that fresh orange juice had the most vitamin C and another wrote Sunny Delight® was highest. In terms of being the lowest in vitamin C content, four wrote that Mountain Dew® would have the lowest, one wrote that "pepper juice" was lowest, while the others did not answer that question. Another reflection question asked if the way a food was prepared affects the vitamin C content. Most students replied that vitamin C content would lower with cooking, however all six students were unsure as to why this would occur.

Students were divided into groups of four. Each group was responsible to test six different juices three times for the presence of vitamin C. Students placed one milliliter of the indicator solution, indophenol, within each test tube. Students then carefully dropped the sample juice or drink into the test tube until the indicator either became clear or until its color no longer changed.

The journal reflection questions showed some inconsistencies in the student results. Students were asked to determine which drink had the highest vitamin C content. One student reported that Sunny Delight® had the highest vitamin C content. I can only guess that his group mislabeled their test tubes or that they did not swirl the test tube after each additional drop of juice. Three of the other students wrote that boiled orange juice had the highest vitamin C as it only took two drops of the juice to change the indicator to a clear color. The remaining two students did not answer this question.

All six students reported that bottled orange juice had less vitamin C than fresh orange juice. They all wrote in their journals that processing does affect the vitamin C content within a product. What puzzles me is that when it came to the post test, two of the six were unable to respond positively to the question, "Does it matter whether orange juice is fresh or bottled, when considering the amount of vitamin C present? Why do you think so?". Perhaps more class discussion was necessary since all of the students clearly still did not have the cause and effect relationship solidified. I could make the lab groups smaller using two students per group instead of four, making sure that all of the students have a hands-on experience with the vitamin C laboratory investigation. I could also split this lab into two separate activities in which one qualitatively analyzed different beverages for vitamin C and the other activity investigated storage and processing of drinks. With the later activity, I could have student groups share and make sense of the separate data collected, allowing them to form ideas explaining changes in vitamin C content.

In an "application" journal response question, students were asked how they would ensure that they would consume the recommended daily allowance (RDA) of vitamin C. Three of them stated that they would consume orange juice, while another wrote that she would take a vitamin supplement (we never discussed these in class), and the last two students did not provide an answer. This shows that it can be difficult for students to apply what they have learned to their own situation. I should provide more practice for my students using further discussion and laboratory situations so that they can correctly apply this information.

LAB – Lactaid™ to the Rescue! (C3)

Since I am trying to use examples of food and nutrients from popular culture, I developed a lab using a product like Lactaid™ a product which commonly has advertisements on television. The purpose of this lab was to give students an experience with the terms "lactose intolerance" and to recognize that nutrients affect people negatively. A secondary outcome of this lab was that students would understand that enzymes are required for the digestion of certain nutrients, and that temperature can affect the ability of an enzyme to work within the body. The pretest revealed that about half of all students knew that lactose was a type of sugar in milk. This seemed reasonable; students have probably heard the terms "lactose intolerance" in television commercials for products like Lactaid™, or perhaps they may know someone who has a problem digesting lactose. The reflection questions told me, however, that even though some students know what lactose is, they did not understand the connection between the specific nutrient lactose and being lactose intolerant. Five out of the six students wrote that being lactose intolerant means that a person cannot consume dairy products and wrote nothing of being unable to digest the sugar, lactose. All six students were able to characterize enzymes as proteins. However, they could not explain their function.

During the laboratory investigation, students were given samples of milk, either at room temperature or refrigerated temperature, each with either boiled lactase, unboiled lactase, and no lactase. Students were then given glucose strips to test for the activity of the enzyme, lactase which breaks down the disaccharide lactose into the monosaccharides galactose and glucose. Students observed the effects of temperature on the activity of an enzyme by measuring the content of glucose. More importantly, students inferred the levels of lactose within milk while using the glucose strips.

After completing the activity, five out of the six students stated that they knew the Lactaid™ worked because the glucose strip changed in color; however, only one student wrote that this change was the direct result of lactose being digested by the enzyme lactase. All six students recognized that the inability to digest milk sugar is called "lactose intolerance".

When asked if anything in the lab sped up or slowed down the activity of the enzyme, all six reported that temperature affected this activity. They stated that the amount of glucose indicated by the strips told them how much the enzyme worked. Four of the six students wrote that heat sped up the activity, while the other two stated that colder temperatures slowed the activity of the enzyme. Only two of the students wrote anything about how boiling the enzyme destroyed its ability to work. When asked to explain the title of the lab, four of the six students were able to write about how people who are lactose intolerant can use Lactaid™ for digestion of dairy products.

After I analyzed this laboratory activity, it appeared that the test questions needed to be rewritten so that they clearly measured the objectives to be learned by the students during the activity. In the case of this laboratory and the test, only one question addressed a concept discussed in the lab. More questions are needed to accurately assess the learning and retention and of knowledge by students. A better question would have been, "Which nutrient found in milk can affect people adversely? What is this problem called and what can be done about it?"

LAB – Are Nutrients Found in What You Drink? (C4)

Students were given another opportunity to use indicators on different drinks and to determine the specific gravity of each. The purpose of this laboratory exercise was to reinforce the idea that various nutrients are found within foods by measuring the density and that these nutrients affect the nutritional value of a food. The pretest showed that students were confused about the relationship between being nutritious and having specific nutrients within a given food item. Very few students were able to provide a specific example of how the presence of a nutrient made a food nutritious. Many simply wrote that a food is nutritious because is has nutrients in it. There was no mention of the types of nutrients or the amounts of nutrients found in the food. In a reflection question addressing the same types of issues, one student wrote that milk was the most nutritious of all the drinks that he had consumed that day because it contain over four hundred different types of fats. The misconception is that having more of a particular type of nutrient means that the food is more nutritious. Another misconception revealed by the reflection questions was that water is the most nutritious drink. I understood why so many students wrote this since I had told them earlier that week that water was the most vital of all the nutrients since humans could only live without it for about five days. The students obviously were confused about something being vital and something being nutritious. To clear up these terms before the lab, we spent some time discussing what made a food nutritious. I brought in instant rice, a turkey sandwich on wheat bread with mayonnaise and lettuce, and a pop tart. This encouraged students to speak about which food was more nutritious and why. I stressed the idea that more of a particular nutrient does not always mean that it can make a food more nutritious.

While completing the lab, students worked in groups of four. Each group was assigned a specific drink to test using the indicators Biurets reagent and Lugols solution. Students also had to characterize the density of the drink by using a hydrometer. It was apparent after reading the students' pretests and reflection questions that they had no idea what a hydrometer was, how it worked, or what it measured. Students were introduced to using a hydrometer prior to completing the lab activity. A copy of the activity using a hydrometer can be seen in the Appendix (C5). The hydrometer was something that students were fascinated with and enjoyed using. Since they were familiar with the use of the various indicators, this portion of the lab went smoothly. In addition to using indicators and a hydrometer, students were also required to read the food label of the drink they were investigating. This was done partially to prepare them for the next series of laboratory investigations, but primarily to have them evaluate the nutritional content of the drink in relation to the nutrients for which it tested positive.

As revealed by the journal response questions, students were able to identify various nutrients within the drinks. They were also able to make the connection between the nutrients found and the nutritional value of that drink. When asked if a soft drink was a good source of nutrients, all six target students replied that it was a poor choice. They said that the soft drink was full of sugar and that it contained no proteins or vitamins. The next part of that question asked students whether a diet version of the same soft drink would be a better choice. Four students replied that it was a worse choice than the regular soft drink. The other two students concluded that being a diabetic was a good reason to consume the diet soda rather than the regular soda.

The post test showed that students learned from this laboratory experience. All six students cited milk as being the most nutritious of all of the liquids tested, which was my intention in this laboratory exercise. Most students wrote that milk was the most nutritious because it contained all of the categories of nutrients. Only one wrote of milk being nutritious because, "...it has fats that our body needs." This was the same student who wrote the statement about milk being nutritious because of all the different fats it contained. The misconception that this student had about what makes something nutritious did not change even after completing two weeks of activities. This example served as proof that what a student believed to be true, otherwise termed as an alternative framework, was indeed difficult to change even with hands-on activities and personal experiences.

All six students also demonstrated on the post test the understanding of how a hydrometer worked. Their interest was captured during this portion of the laboratory experience, and many included a drawing of the hydrometer in their post test. The response question, "What could (specific gravity) indicate about the nutritional value of that liquid?" was a source of confusion for students. Four out of the six students wrote that the higher specific gravity readings indicated that the liquid was more nutritious. They did not speculate that the density of a liquid does not necessarily correspond to the nutritional value of the liquid. I do not blame the students for being unable to make this connection. I should have worded the question differently: "What is the relationship between a liquid's specific gravity and its nutritional value?" I need to spend time developing activities which would allow students to understand the difference between the chemical and physical characteristics of a food.

LAB – Whose Urine Is It? (C6)

Since students should have a grasp of what a nutrient is and that nutrients are found in foods, the next step was to help them determine the relationship between what was eaten and the health of an individual. The pretest indicated that students did not understand how urine could provide clues to a person's health. It also indicated that they could not provide a specific example of how unbalanced nutrition affects a person's health. Next I will describe the urinalysis lab as well as student progress related to the lab.

Before students completed the lab, it was necessary to have a class discussion about the clues imbedded within each scenario described in the laboratory handout. The lab begins with a fictitious history of three patients and the possible compounds which may be present in their urine samples. I discovered the first time after implementing this exercise that students asked questions about the significance of patient behaviors like eating only grapefruit for a month or urinating frequently coupled with a lack of energy. They also wondered about possible health consequences which could be indicated in urine. I was reminded that seventh grade students lack the physiological knowledge to make inferences about food choices and possible health outcomes without teacher guidance.

The purpose of this laboratory experience was for students to test simulated urine for the presence of compounds which could indicate a health problem. This would in turn introduce them to the connection between food choices and diseases like diabetes. The laboratory investigation involved a scenario in which three urine samples were "mixed up". It was the students' job to read over the patient histories, interpret the symptoms, and then to make a prediction about the compounds which could be present in the various urine samples. Students worked in pairs and were given a beaker with an unknown urine sample. They then used urinalysis strips to identify the compounds found in the urine. Based on the results, students then indicated which urine sample they had and why they thought so.

This was an easy lab to complete since it simply involved dipping urinalysis strips into synthetic urine, and then interpreting the results as indicated on the strip. The journal response questions showed that only two of the six students were able to establish the connection between eating an unbalanced diet and finding compounds in the urine that could possibly indicate the presence of a disease. I thought this was the case because there was some confusion over the words "unbalanced and balanced nutrition". We did not complete any activities which would have cleared up these terms for the students. Additionally, I should have included a journal response question specific to the term glucose, and how its presence in urine could be an indication of diabetes. Again I see the importance of creating well written questions in order to guide and assess student learning. The ultimate goal of this lab was to allow students to make a connection between what was eaten and how health was impacted, however the processes involving metabolism are pretty complicated. The experience itself was not enough to ensure conceptual change and integration of knowledge by students.

In their conclusion statements, all six students were able to support their choice of which patient's urine sample they possessed. Students were able to base the results of their urinalysis on the clues provided in the patient histories. When asked what further questions they had regarding this laboratory activity, three of the students replied that they wish they could have tested the other urine samples since each group was allowed to choose only one sample. At least I know that they were curious. The other three skipped that portion of the question.

ACTIVITY – Which Drink is the Most Nutritious? (C7)

The next activity completed in class was one involving the analysis of the food labels of three drinks: milk, orange juice, and orange pop. The purpose was to evaluate a food based on the content of its food label and applying nutritional knowledge to a situation. This activity was very similar to what students had done in the past with nutrients and how the proper amounts of them can make a food more nutritious. Additionally, the label analysis activity served as reinforcement for understanding and interpreting a food label for nutritional content. I tried to remove the brand names on each of the food labels since numerous class discussions on the topic of drinks and nutrition had taken place and I wanted students to evaluate these liquids based on how they interpreted the food label. This assignment was a given as homework. Most students chose milk as the most nutritious. However, the misconception that "more is better" came up again. A few students wrote that milk was more nutritious since it contained the most sodium. Certain trains of thought are difficult to stop!

LAB - Is Energy Stored Within Food? A Calorimetry Demonstration (C8)

By this point in the nutrition unit, students should understand what a nutrient is, be able to determine whether one food is more nutritious than another and be able to explain how food choices can positively or negatively impact health. The next step I wanted my students to make was to understand the concept that energy stored in food is measured in the form of calories. One way to demonstrate the idea of energy stored in food is to complete a brief study on calorimetry. The purpose of the calorimetry activity was to allow students an opportunity to witness the stored energy (through burning) in a food and then to calculate the amount of energy stored in that food. Another objective of this activity was to apply nutritional understanding to the idea that caloric amounts influence the nutritional value of a food.

Even though we had discussed the idea of stored energy in food, specifically that associated with certain nutrients, students still could not explain why certain types of foods provided more energy than others. They were unable to make the connection between food, the nutrients they contained, and the amount of energy stored. Only one of the six students in the reflection questions said that a fatty food contained the most energy. The students were also confused with the term "empty calories". When asked what it meant, four of the six revealed that a food containing empty calories was one which did not have any calories. Either the students have not connected nutritional value to the amount of calories within a food, or they did not understand the terms used. A better reflection question would have been, "Why can't we survive well on only chocolate bars?".

During the demonstration, I used different students to help me with the calorimetry of a Better Cheddar© cracker. I chose this food because I knew that it would burn readily. The class then recorded the data as the student helpers called it out, and we completed a chart as a class. This part of the lab required a class period. The next day the class discussed what they had seen and the concept of calories. Following the discussion we completed the calculations to determine caloric content together. Finally, students were given time to write their journal response entries.

The journal response questions indicated that all six students understood that energy was stored in food because the food burned and the temperature of the water in the calorimeter increased. They also demonstrated this point by writing the answer to the question, "Are calories found within food?" as "yes" in their conclusion statement by restating how they witnessed the food burning. The misconception persisted that there was no connection between caloric amounts and nutritional value of a food. Only two of the six students were able to write that food contains calories and that these calories come from proteins, fats, and carbohydrates. I should have provided a calorimetry experience in which a variety of foods were tested instead of only crackers. This may have provided the students with more experience and more time to form the necessary connections between nutritional value and the calories. I also need to be more active in reviewing student work in progress and provide suggestions or further questions when it appears that students are not making the intended connections.

On the positive side, the results of the post test show excellent progress with this portion of the nutrition unit as the class average was slightly above eighty-five percent. I was pleased that my students were able to demonstrate a mastery level of understanding with these concepts. I need to examine why so many students were successful and provide the same types of experiences consistently throughout my curriculum.

Activity – Better Cheddar® Label Analysis (C9)

The final activity of the nutrition unit coincided with the calorimetry demonstration. Students were provided with a copy of the nutritional label to the Better Cheddar® crackers. The purpose of this activity was to give students practice interpreting what was on the label and determining the nutritional value of the food. Students were given a short time to complete the worksheet in class and a discussion followed.

EVALUATION

I. Pre and Post Tests (Appendix B)

The questions on the pre and post tests were written in short answer format. They were designed to elicit student responses that could demonstrate learning of nutritional concepts at all levels of Bloom's taxonomy. I tested the students on three separate occasions throughout the five weeks of the unit generating three sets of pre and post tests. The two classes of students involved in this study were similar in academic stature, attitude, and interest in nutrition. Students in both classes made significant gains over the course of the unit as measured by these instruments. The results for the first class studied, "A", are shown in Table 1.

Table 1. Pre and Post Test Data for Class A

	n	Mean	Percent (%)	Standard Deviation	Range
Pre test I	24	6.9	23	3.85	1-14
Post test I	24	21.5	72	5.15	11-19
Pre test II	24	1.8	9	2.37	0-10
Post test II	24	13.6	68	4.20	8-12
Pretest III	25	1.2	8	1.10	0-3
Post test III	25	8.2	55	3.40	1-12

The implementation of the nutrition unit in Class A involved my traditional approach with lecture first and the newly created laboratory exercises following. Students in this group demonstrated an increase in knowledge about nutrition (Table 1). The class mean increased by 14.6 points on the first pre to post test, an improvement of forty-nine percent. The second test mean increased by 11.8 points, with an increase of fifty-nine percent, pre to post. The third and final post test mean increased by 7 points over the pre test, an increase of forty-seven percent. What is interesting with Class A, is the gradual decrease in post test averages with each test administered. The first post test's average was seventy-two percent. The second post test's average was sixty-eight percent and the third post test averaged a lowly fifty-five percent. I think this is a direct result of the types of questions asked on the tests and the activities which were taking place in the classroom. The nutritional concepts which students were expected to learn became increasingly geared toward deeper learning in the application, evaluation, and synthesis levels of understanding. The classroom experiences of my students probably did not allow them to understand the concepts at the level that they were being tested since they had very little writing to learn experiences.

The implementation of the nutritional unit in Class B involved more of a constructivist approach to teaching because it included journal writings and class discussions. The mean score for all three post tests was considerably higher than that of Class A. The results for the second class, "B" are shown in Table 2.

Table 2. Pre and Post Test Data for Class B.

	n	Mean	Percent (%)	Standard Deviation	Range
Pre test I	19	6.9	23	3.95	0-12
Post test I	19	23.7	79	3.64	15.5-29.5
Pre test II	20	2.2	12	1.78	0-6
Post test II	20	15.5	78	3.22	9.5-20
Pre test III	19	1.5	10	1.31	0-4
Post test III	19	13.2	88	2.10	8-15

With the first set of pre and post tests, the mean score increased by 16.8 points, an increase of fifty-six percent. The second post test showed an increase of 13.3 points compared to the pre test, an increase of sixty-six percent. The final test showed an increase of 11.7 points pre to post, an increase of seventy-eight percent. The class averages in each of the three post tests were all above the highest score of Class A. Class B post test averages were seventy-nine percent for the first post test, seventy-eight percent on the second post test, and an incredible eighty-eight percent on the final post test. The high success rate for Class B on the third post test suggests a correlation between constructivist labs with journal writing and the types of questions found on the test.

II. New Teaching Strategies

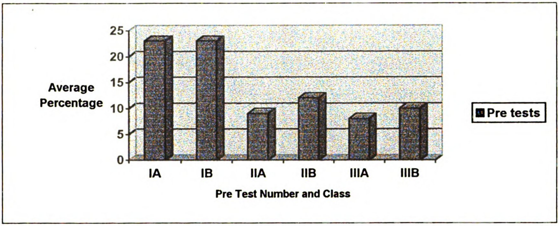
Laboratory experiences appear to increase student learning as seen in the pre and post test comparison for both classes of students. The next question that I had was whether the change in unit implementation between Class A and Class B was statistically significant. In order to compare the independent test means between Class A and Class B, a series of Student's *t* test was done. The pre tests between both classes was compared statistically (Table 3). This was needed to show that the post test gains were actual and that both classes started at the same level of understanding. A graph comparing the pre test average percentages between the two classes is shown in Figure 1.

Table 3. *t* test Results Comparing the Means of Three Sets of Pre Tests from Classes A and B.

Data where H_0: $\mu_1 = \mu_2$ and $\alpha = .05$	**Degrees of Freedom**	***t* test**	**Reject or Accept H_0 (No difference between pre test scores)**
Pre test IB – Pre test IA	41	.043	Accept
Pre test IIB – Pre test IIA	42	.571	Accept
Pre test IIIB – Pre Test IIIA	42	.792	Accept

The results (Table 3 and Figure 1) show that both classes started out at the same level of understanding of nutrition. There was no significant difference in the average of the pre test scores between the first class studied and the second class.

Figure 1. A Graph Comparing the Pre Test Averages of Tests I, II, and III Between Classes A and B.

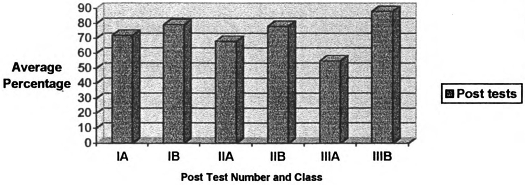


A second *t* test comparing the independent means of the post test scores from each class shows a statistically significant difference in post test scores of Class B over Class A only for the third test (Table 4 and Figure 2). Students in Class B scored seven percent higher and ten percent higher than in Class A on the first and second post tests respectively (Tables 1 and 2). Despite the fact that the post test comparisons for tests one and two were not statistically significant, I am convinced when I read the student responses to test questions that there was a difference in student understanding between the two groups.

Table 4. *t* test Results Comparing the Means of Three Sets of Post Tests from Classes A and B.

Data where H_o: $\mu_1 = \mu_2$ and $\alpha = .05$	Degrees of Freedom	*t* test	Reject or Accept H_o (No difference between post test scores)
Post test IB – Post Test IA	41	1.55	Accept
Post test IIB – Post test IIA	42	1.72	Accept
Post test IIIB – Post test IIIB	42	5.65	Reject

Figure 2. A Graph Comparing the Post Test Averages of Tests I, II, and III Between Classes A and B.



In studying the answers given by students on the post tests from the two classes, there was a difference in the depth of the answers given. One example is the response to the question, "Why is it important to know what nutrients are found within food?". Most of the students in Class A wrote answers similar to the following response, "It's important to know what nutrients are found within a food so you would know if it is healthy or not". This leaves me wondering what the student means by the term, "healthy". In Class B, the answers were more specific and showed signs of making connections with their prior knowledge. One such response to the above question was, "It is important to know what nutrients are found in foods so we can eat right, not have too much of one thing, and avoid things we're allergic to".

In another question, "Explain the following statement: Milk is Nutritious", a far greater percentage of students from Class B were able to respond with specific examples. One student wrote, "Milk is nutritious because of all the nutrients in it like calcium, protein, vitamins, and carbohydrates." A few students in class A responded similarly to the students in Class B. However, over half of Class A lost points because they were unable to provide more than one nutrient found in milk as the reason why it is nutritious. Both classes completed the same lab activity, but Class B had the lab experiences and the additional constructivist support both before and after completing the laboratory activity.

III. Student Evaluation

Students were given a survey (Appendix D) which asked questions about nutritional knowledge, laboratory investigation preferences, and changes that could be made to the unit. These students were asked to number each learning activity between one and six, with one being the highest or most helpful and six being the lowest or least helpful. Although both classes of students were given surveys to fill out, only in Class B were students asked to rate which classroom activities helped them to learn the most. The results from these questions are summarized in Table 5.

Table 5. Student Evaluations of Teaching Activities Used in Class B.

Teaching Activity	**Effectiveness Mean Score**
Completing a Lab	3.06
Taking Notes	3.18
Watching a Demonstration	3.41
Listening in Class	3.59
Discussion with Classmates	4.35
Writing in a Journal	4.81

Students felt that laboratory activities were the most useful in helping them to learn. The laboratory activities appear to motivate students to learn. I was surprised to learn that students felt that taking notes helps them to learn almost as much as completing a lab. As I analyzed the survey results, I noticed that almost as many students who rated a particular question a high rating of "one", almost an equal number rated the same question low "six". In general, the high mean scores for the results of Table 5 may be a result of students not recognizing their own learning styles.

Another survey question asked which learning activity students enjoyed the most. The highest number of students replied that labs were the most fun, with watching demonstrations next, followed by classroom discussion, and finally listening in class. No students listed taking notes or writing in their journals as being the most enjoyable learning activities. Both groups of students were asked which laboratory activity stuck out the most in their mind. Out of the forty-six students responding, twenty-five wrote the "Urine lab", nineteen wrote the "Calorimetry lab", and two wrote the "Milk lab" otherwise known as, "Lactaid™ to the Rescue!"

According to the survey, students felt that classroom discussions and writing in their journals were the least helpful. I found these responses interesting. What my students' thought about what helped them to learn was contrary to what my study about constructivist teaching and learning demonstrated. There appears to be a positive correlation between what was learned and the use of writing in addition to laboratory experiences with Class B. I can state this because of the comparison between post tests and the average increase in scores of Class B over A.

DISCUSSION

I. What was Effective

Using laboratory experiences coupled with writing-to-learn activities proved to be the best way for students to construct knowledge about some aspects of nutrition because in each of the three tests, students in Class B scored higher than in Class A. If students are to achieve deeper levels of understanding, it is not enough to implement laboratory activities without providing the opportunity to connect prior knowledge to the new concept. The use of the "Health Journal" with the second class proved to be an invaluable tool in achieving this goal. The reflection question responses, which were required before each laboratory activity, gave me a glimpse of what the students understood about a topic. This was a technique that I had never employed in any of the classes that I had taught. Not only did the reflection questions serve me as an instructor, but they also served as a means for creating curiosity and conflict about a concept for the student. Instead of solely trying to complete an activity and get a good grade, students were starting to ask how they could change certain variables within an experiment. One example of a question a student asked after completing the reflection questions on a particular lab was, "How much protein is in an ant?" I think that this would make a great laboratory investigation and could lead into some interesting discussions. Other students became actively involved in the laboratory investigations and started to bring in their favorite drinks and snacks to test for the presence of different nutrients. I rarely had students showing so much curiosity before the use of constructivist methods.

By allowing students to process the information in terms to which they could relate, students should be able to construct knowledge at a level which would allow them to apply it to a different situation. This was accomplished through student driven discoveries by lab experiences and journal writings. Students were able to demonstrate a deeper level of understanding by their written responses to purposeful questions whose answers were found within the labs. One such example came after completing the lab called, "Lactaid™ to the Rescue" (Appendix C). In response to the question, "How can our body temperature and the effects of having a high fever impact our health?" one student wrote, "I think our body temperature and the bad effects of having a very high fever impact the many enzymes found in our bodies because heat destroys the enzymes and they won't work ". This student demonstrated how the laboratory experience with the lactase and the heating of it led to a connection with understanding how enzymes work within people.

Another change shown to be effective was the revision of the conclusion statement students wrote after completing a laboratory investigation. Before the implementation of the unit, I simply asked students to summarize what they learned after doing the lab. This type of questioning is not specific enough to lead students to write about the connections made between prior knowledge and the new construction of knowledge. With the new conclusion statement, I could determine whether students understood the purpose of the laboratory investigation. Additionally, I could also gain a sense of their reasoning abilities by the way they supported their answers.

As an instructor, I also appreciated the additional questions about an investigation students posed following the completion of a lab. After completing "Are Nutrients Found in What You Drink?", one student wrote in their conclusion statement, "Nutrients are in liquids. I know this because we tested different kinds of liquids and there were proteins and glucose and we looked at the back labels. Some questions I have are 'What's so important about density?' and 'Is it good to have density?'". From the statements that this student made, I can tell that the purpose of the lab was understood and the logic used to support the answer was correct. Additionally, I was able to determine that the portion of the lab which pertained to the hydrometer and to the density of liquids needs to be clarified.

The conclusion statements written after completing "Whose Urine Is It?", indicate that students wished to test additional urine samples. One student writes, " In the lab I found out that I had patient 1 because of what I found in his urine. I am wondering what the other patients had and how much of it they had in their urine." I will change this activity and allow students to test all urine samples. This will allow students to become more confident about their interpretation of the test strips as each urine sample provided has different compounds present. Another student writes, "The purpose of this laboratory investigation is to know about what can happen to your body if you do not eat a balanced diet... Do we need ketones?" . This conclusion statement indicates that I need to provide additional learning activities which address the compounds found in urine as well as what the presence of these compounds may indicate about the health of an individual. In either case, the conclusion statement provides the teacher with a snap shot of the learning which has occurred and indicates the changes that need to take place allowing specific learning objectives to be accomplished.

II. Changing the teaching of other units

The power of reflective questioning has changed me as a teacher. I plan to incorporate this teaching technique in all of my future laboratory investigations. I can also recognize the importance of including more writing-to-learn activities in all of the classes I teach. I liked using the journals as a means of assessment, and I plan to continue using them. The journals served as a tool in following the thinking patterns of students as they changed over time. They also helped me find the flaws with the questions I was using to measure student learning. The well thought out question is invaluable with helping students to reach a deeper level of understanding.

Another change in teaching style which I plan to implement into other units, is to give students a laboratory experience before the information has been given on the topic. This causes students to engage in a topic with their own thoughts, allowing for true and lasting changes in their understanding. Changes like these will take time, since I will have to reorganize my teaching strategies. I am confident, however, that my students will benefit and become better thinkers after integrating this style of instruction throughout my curriculum.

III. Aspects of the unit that need improvement

When comparing the test questions with the laboratory activities completed, it was easy to understand why students in Class B did much better on the second post test and very well on the third post test. Over half of the questions on the second test were related to three laboratory activities which students had completed. As the Class B average of eighty-eight percent indicated on the third test, every test question was directly linked to the four activities which had taken place during class. Contrary to the third test and second tests, the first test could use some improvement. I need to be better aware of what my instructional goals are and to have the test questions measure the desired learning outcomes. Additionally, I need to create more lab activities, particularly in the first section of this unit. This is especially true since students were asked a variety of questions, yet only one laboratory activity had taken place by this point in the unit. Most of the questions from the test were derived from the notes rather than from the laboratory investigation.

Another change that I would make in this unit is to encourage additional higher level thinking within the journal response questions. As I looked over these questions, very few of them provided students with an opportunity to apply what they had learned to a new situation. Students can only show what they understand when given well thought out questions and laboratory experiences.

I also wonder about student attitudes. On the survey I should have asked whether "encore" classes mean as much to students as "core" classes. If students feel that encore classes are not as valuable, they may not work as hard as they could to understand the concepts they are being introduced to during class. I bring up this point because students indicated on the survey that writing in their journals was the least useful in helping them to learn. The truth is writing is hard work because it forces a person to think. My study shows that students learned more as a result of completing the laboratory experiences in conjunction with the journal writings and discussion. I had hoped that their attitudes would have reflected their success.

Another interesting point of study would be to have given these two groups the same set of tests a month after completing the unit. It would be informative to measure how much students retain knowledge in comparison to the learning/teaching methods used during class.

V. Conclusions

I can now understand why some of the best learning occurs when students are allowed to question, write, and investigate through personal experience a challenging concept. I now appreciate the constructivist model as a means to allow my students the best chance for learning in the science classroom. Learning occurs at a deeper level when students use laboratory experiences coupled with journal reflection and response questions along with classroom discussions. As a teacher I must be purposeful in designing laboratory activities which will enable students to achieve the learning outcomes desired. The power of pre-lab activities like the journal reflection questions should not be overlooked as they can open a teacher's eyes to the level of knowledge that their students have at any given time. This can allow a teacher to adjust the learning/teaching strategy as needed by that particular group of students. The journal response questions need to be well thought out and able to measure student understanding. They should guide student thinking in the construction of new knowledge. If a teacher wants to find out if the purpose of the lab is understood, a specific laboratory conclusion statement must be required from the students. Finally, after the labs, journal responses, and discussions have occurred, the test questions need to consistently reflect the constructivist learning activities which have taken place.

I enjoyed this style of teaching as I found that there was less student confusion surrounding the purpose of the laboratory investigations and students seemed to have a better grasp of the procedures. This new style of teaching also increased the level of teacher responsibility, as I had the additional reading of journal reflection questions before students could complete a lab. However, it also increased the responsibility of the student for his or her own learning.

I am pleased with the student learning outcomes resulting from the implementation of this unit on nutrition. I know that I have become a better teacher and my students will benefit for years to come.

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APPENDIX A

Resources

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APPENDIX B

Pre and Post Tests

Nutrition Test Part I
Carbohydrates, Proteins, and Fats

Read the following questions carefully and answer the questions the best that you can with as much information as possible.

1. Define the word : **nutrient**

2. Identify which of the four examples is not a nutrient and explain your answer. A) Carbohydrates B) Water C) Hormone D) Protein

3. What is the most popular food additive in the U.S.?

4. Explain why natural sugars are more beneficial than refined sugars?

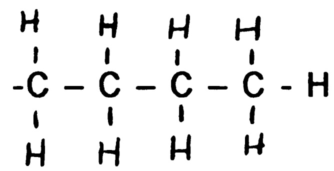
5. What is "blood sugar"? (Do not write – "sugar that's in the blood")

6. Name a food, which you think is nutritious, and explain your answer.

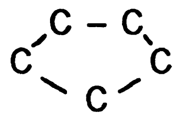
7. How can excess sugar impact your health? (Give two consequences.)

8. Look at the diagrams below and choose the molecule that is a sugar.

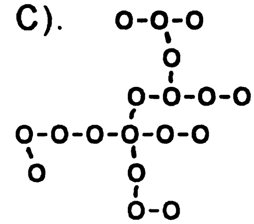
A).



B).



C).



9. Explain why eating whole wheat bread is better than eating white bread.

10. Name a food which is a good alternative to having sweets.

11. Which nutrients do fruits and vegetables contain? How do you know?

12. Name a food that is rich in carbohydrates. How do you know?

13. What function do **carbohydrates** perform within the body?

14. Name a food that is rich in proteins? How many servings of protein do you need a day to be healthy?

15. What makes one food more nutritious than another?

16. What function (job) do **proteins** perform within the body?

17. How can too much protein damage your body?

18. Which type of fat is a solid at room temperature?
    Circle one: Saturated Unsaturated

19. Name the type of fat which has been shown to clog arteries?

20. Fats are necessary for good health. Explain.

21. True or False: A food can contain more than one nutrient.
    How do you know?

22. Why is it important to know what nutrients are found within food?

23. If you were given a mystery liquid and asked to determine which nutrients it contained, how would you determine this?

Nutrition Test Part II.
Milk, Water, Additives & Preservatives, Minerals, and Vitamins

1. Name the sugar that is found in Milk and the enzyme which is needed to digest it. What is the term given to someone who cannot digest this milk sugar?

2. Explain the following statement: Milk is nutritious.

3. Explain how the specific gravity demonstration showed how much "stuff" is in a liquid? Which liquid had the highest amount of particles in it? What could this indicate about the nutritional level of that liquid?

4. What is our most vital nutrient? Why do you think so?

5. What are FOOD ADDITIVES and provide an example?

6. Explain how vitamins are different from minerals?

7. Provide a specific example of how nutrition affects our health:

8. True or False . A food like green pepper can contain more vitamin C than fresh orange juice. Explain how you know.

9-10. Does it matter whether orange juice is fresh or bottled when considering the amount of vitamin C present? Why do you think so?

Nutrition Test Part III.
Calories and Effects of Nutrition on Health

1. Which nutrients provide energy to the body?

2. Which nutrient holds the greatest amount of energy per gram of that food type? How do you know?

3. What is a Calorie?

4. Look at the food label. Which nutrient provides the greatest number of calories? What percent of this food is fat? Show your work.

5. What device can be used to determine the amount of energy found in a food sample? Explain how it works.

6. Explain how urine can supply clues to show the health of someone.

7. Using what you have learned from this entire nutrition unit, explain how nutrition can effect the body? Provide an example of each situation.

   a) Balanced nutrition:

   b) Unbalanced (poor) nutrition:

APPENDIX C

Labs and Activities

1. Which Nutrients Do Foods Contain?

Purpose:

By using different nutrient indicators, you will be able to determine which nutrients are found within various foods. Two of these indicators are for carbohydrates (one for sugar, and the other for starch, both of which are carbohydrates), and the other test is for proteins.

For all of these tests, we will start with four very simple foods, and then use a few more foods that you can bring from home. This will allow you to test some of your favorite foods.

Each lab group will be in charge of testing for a specific type of nutrient found in food. Be sure to record which test your group has been assigned.

Materials:

-Safety goggles
-A grease pencil
-Several foods:
  Corn starch dissolved in water
  Glucose (sugar) dissolved in water
  Gelatin dissolved in water
  Mystery food solution
-Other foods for testing such as:
  banana, oatmeal, egg white
  spaghetti, cheese, milk
-Chem-plate
-starch indicator (iodine)
-sugar (glucose) test strips
-protein indicator (biurets solution)

Step 1. Reflection

In your journals, attempt to answer the following questions:

1). What nutrients are found in foods like gelatin, bread, milk, and mountain dew (pop)? Write about each food.

2). Describe how could you find out which nutrients are found in these foods?

3). Why is it important to know what kind of "stuff" is found in foods?

4). Is it possible for a particular food to have more than one nutrient? Explain.

5). If you could test a food, what would it be?

Step 2. Action

- Place a few drops of the food item to be tested into each well of the chemplate.
- Use the indicator solution and place four-five drops of it into the well with the liquid you are testing.
- Observe any color changes in the indicator solution.
- Fill in the data chart below to record your results.
- Does any food item contain more than one type of nutrient?
- How could you design this experiment to test for this? Do it. What happens?

Step 3. Results

Your group's assigned indicator: ____________________

Note: You will be completing the ENTIRE chart during the class discussion!

Forms of Carbohydrate

Substance to be Tested	Starch indicator: ______________ ______ color change no change		Sugar indicator: ______________ ______ color change no change		Protein indicator : ________________ ____ color change no change	

Step 4. Direct Teaching

Take notes in your journals on your teacher's explanations of what you have just seen. Be prepared to discuss your own ideas with the class as well.

Step 5. Journal Writing – Think and write about the following:

1. Which nutrients did your food items contain? Explain how you know.
2. How was an indicator helpful in this experiment?
3. Based on your observations, which nutrient does your mystery food solution contain? Why do you think so?
4. If a food item did not respond to the indicator, does this mean that it contains no nutrients? Explain.
5. Wait to answer this question until after the class discussion. Which foods contained more than one component?
6. Why is it important to know which nutrients are found within foods?

2. Vitamin C – Do You See It?

Purpose:

During this laboratory investigation you will be able to test for the presence of vitamin C using an indicator. You will find out if the way that a juice is prepared affects the amount of vitamin C in it.

New concepts:

Many foods contain molecules called vitamins. Ascorbic acid, or vitamin C, is found in a wide variety of foods including citrus fruits and some vegetables.

The chemical properties of vitamin C allow it to be detected in given foods. We will be using an indicator called indophenol. Indophenol is normally blue when dissolved in water. In this experiment the chemical indophenol will be used to test for the presence of vitamin C. When vitamin C is present, indophenol becomes colorless.

Materials:

Indophenol Solution (indicator for Vit. C)

100 ml beaker (one per group)
distilled water
pipettes
50ml beakers which hold sample juices
variety of juices and drinks:
- fresh orange juice
- bottled orange juice
- boiled orange juice
- light exposed orange juice
- fresh pepper juice
- Gatorade/sports drink

10ml test tubes (18 per group)

Step One: Reflection

In your journals, attempt to answer the following questions:

1). Rate the following juices for vitamin C content:
(Low High None)

fresh orange juice	Sunny Delight
bottled orange juice	fresh pepper juice
orange juice exposed to light	Powerade
orange juice that has been heated	Mountain Dew

2). Considering the above list, predict which drink has the highest amount of vitamin C. Explain. Which has the lowest? Explain

3). Do you think that the way a food is prepared will change the amount of vitamin C found in it? Design a way to figure this out.

4). What do you think vitamin C does for the body? Is it a vital nutrient? Explain.

Step Two: Action

Measuring the amount of vitamin C in various samples:

- Set up your lab area by getting a large beaker with the 18 test tubes filled with the indicator solution. You will be testing each sample three times.
- Choose six sample juices to test. You must pick at least three of the orange juice samples.
- Use a different pipette for each different sample liquid being tested. Place one drop at a time into a test tube containing the blue indophenol solution. Swirl/invert test tube after each drop.
- Carefully count the number of drops it takes until the indophenol solution becomes colorless. Be sure to swirl after each drop. Record the number of drops and any observations onto the chart provided.
- If your group has added a lot of drops (>20) then keep going until you note that the color changes from the dark blue to a lighter color and record this number in the results table.

- Repeat the above steps for each sample being tested. Test each juice three times and obtain the average number of drops needed to change the indicator.

Predict which juice will have the highest amount of vitamin C:

____

Step Three: Results

Type of Juice	Number of Drops Needed to Change the Indicator				
	Trial 1	Trial 2	Trial 3	Average	Color Solution turned:

Step Four: Direct Teaching

Take notes in your journals on your teacher's explanations of what you have just seen. Be prepared to discuss your own ideas with the class as well.

Step Five: Journal Writing – Think and write about the following

1. Which juice/sample had the most vitamin C ? How do you know? Did this result surprise you? Why or why not.

2. Which juice/sample had the least vitamin C? Does this result match up with what the liquid is? Explain.

3. Does the vitamin C amount change depending on the type of juice? (fresh or bottled) Why or why not?

4. What indicator was used? Why do we need to use an indicator to complete this lab?

5. Can the number of drops be determined after one trial? Explain.

6. What type of processing may affect the amount of vitamin C found in a particular food product? Explain.

7. If 60mg of vitamin C is the recommended daily allowance, what could you do to ensure that you would consume this daily?

8. What is the hardest part about this lab?

Teacher Notes: Vitamin C – Do You See It?

Introduction:

Many foods contain organic molecules called vitamins. Ascorbic acid, or vitamin C, is found in a wide variety of foods including citrus fruits and some vegetables. During this laboratory investigation the student will be able to test for the presence of vitamin C and be able to quantify the amount of vitamin C found within a given sample.

Indophenol will be used to test for the presence of vitamin C. The chemical properties of vitamin C allow it to be detected in given foods. Hydrogen atoms from a molecule of vitamin C readily react with chlorine, bromine, or iodine atoms to form other molecules. Indophenol contains chlorine atoms and it is normally blue when dissolved in water. When vitamin C. is present, indophenol loses its chlorine atoms and becomes colorless.

A standard solution of vitamin C is prepared using vitamin C pills. This allows the student to determine the amount of vitamin C present in any given food.

Method/Materials:

2,6-dichloroindophenol, sodium salt
filter paper
Pipettes
baking soda (sodium bicarbonate)
50 ml beakers
variety of juices and drinks
weigh paper
Funnel
blender
distilled water
250 mg Vitamin C pills
test tubes
electronic balance
spoon
test tube rack
50 ml Erlenmeyer flasks

Step 1: Create the Vitamin C Standard Solution

Remove a vitamin C pill and crush it between a folded piece of weighing paper using a spoon. Use the balance to mass out 0.1 grams of the vitamin C. Since the vitamin C does not easily dissolve in water, prepare a 0.1M solution of sodium bicarbonate by taking 0.04 grams and mixing it with 10 ml of distilled water in a test tube.

Add the 0.1 grams of vitamin C to the sodium bicarbonate solution and mix within the test tube. Once the vitamin C appears dissolved (there will be some particles at the bottom of the test tube as these are the packing materials for the pills themselves), add the mixture to 90 ml of distilled water.

Since the concentration of the vitamin C standard is 1mg/ml, there are 0.05mg of ascorbic acid per drop.

Step 2: Prepare the Indophenol Working Solution

Dissolve 100 mg of the 2,6-dichloroindophenol, sodium salt in 100 ml of distilled water. Prepare a working solution of indophenol by diluting the stock solution by a 1:10 ratio with distilled water. The indophenol working solution will have a navy blue appearance, and when exposed to vitamin C, it will become clear.

Step 3: Determine the Amount of Vitamin C Necessary to Turn the Indophenol Working Solution "Clear".

- Place 3 ml of the indophenol working solution into a small test tube. Using a pipette filled with vitamin C standard solution, carefully count the number of drops needed to turn the indophenol solution clear.
- Since it takes 20 drops to equal 1 ml, each drop is 0.05 ml.
- (It should take 11 drops of vitamin C standard or 0.55 mg of vitamin C to react with the indophenol.)
- Record this number for student use.

Step 4: Calculate the Amount of Vitamin C in the Sample Liquid.

Part I.

(1mg/ml) (.55ml) = (y)(average # of drops x .05 ml)
Vitamin C standard   Unknown Concentration
Of Vitamin C

"y" is then a fractional amount of the standard . The next step is to determine how much vitamin C is in the **sample being tested**.

Part II.

Once "y" is determined, multiply this value times .55mg/ml. The resulting value will be equal to the amount of vitamin C in the sample being tested.

3. Lactaid™ to the Rescue!

Purpose:

During this laboratory exercise, you will examine how Lactaid works on foods that contain the milk sugar, lactose. You will also discover how Lactaid can be stopped from working.

New Concepts and Vocabulary:

Lactose	Enzyme
Digestion	Lactase
Lactose intolerant	Lactaid

Materials:

Fresh milk or powdered milk
Lactaid or Dairy Ease
glucose test strips
Test tubes
Chem-plates
Glass stirring rod
Hot plate

Step 1. Reflection

In your journals, attempt to answer the following questions:

1). What does it mean if somebody is "lactose intolerant"? How would a person know if they had this problem?

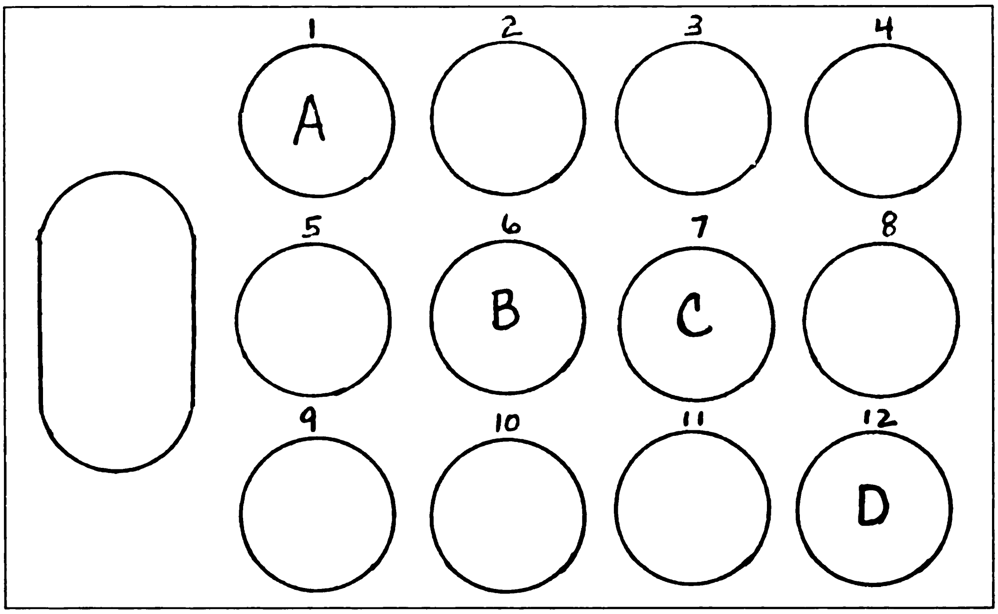
2). What kind of sugar is found in milk?

3). What do you think something like Lactaid does to the milk to allow someone who is lactose intolerant to drink it?

4). What is an enzyme and what do they do for us?

Step Two: Action

- Every group should have a chem-plate and the wells should be filled as follows:



- Use the glucose test strips and test for the presence of glucose in each of the wells. Read the strips after 3 minutes and record the results on the table below.

Well number	Color strip turned after 3 minutes	Amount of Glucose in sample	Did the Lactaid work?

Step Four: Direct Teaching

Take notes in your journals on your teacher's explanations of what you have just seen. Be prepared to discuss you own ideas with the class as well.

Step Five: Journal Writing - Think and write about the following

1. What is the purpose behind using heated lactase in this experiment?
2. What was the max. amount of glucose found in the milk?
3. What result found while completing the lab supports the idea that Lactaid works?
4. Did any process speed up or slow down the enzyme, lactase? Support your answer with evidence gathered from the lab.
5. How do you think our body temperature and the bad effects of having a very high fever impact the many enzymes found in our bodies?
6. What is it called when someone cannot digest foods containing the sugar lactose? Do you know anyone who has this problem?
7. Why do you think this lab has the title that it does?

4. Are Nutrients Found in What You Drink?

Purpose:

During this lab activity you will characterize various liquids using a hydrometer. You will also use various indicators to observe which nutrients are present in the different liquids.

New concepts and vocabulary:

Hydrometer	Specific gravity
Graduated cylinder	Density

Materials:

Various drinks which can include:

Diet pop	chemplates
Pop	biurets indicator solution
Juices	Clinistix or glucose test strips
Gatorade	Iodine solution
Milk	eye droppers
Ultra Slim Fast	250 ml grad. cylinder
Water	food label for your sample
Mystery Drink	

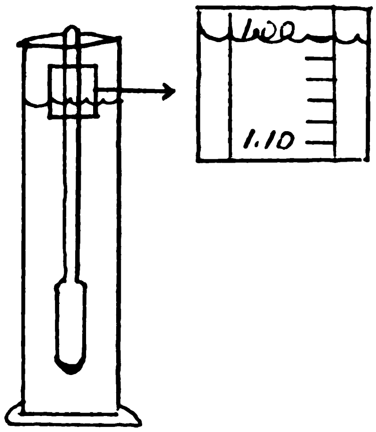
Step One: Reflection

In your journals, attempt to answer the following questions:

1). What do you drink during a typical day? You probably had a glass of juice during breakfast, some milk on your cereal, maybe a drink from the water fountain, and a can of pop during lunch plus whatever you're served during dinner. What nutrients are found in these drinks?

2). Considering everything that you drink during a day, which drink do you think is the most nutritious? Why? Which drink is the least nutritious? Why?

3). Look at the diagrams showing a couple of graduated cylinders with a hydrometer in them. What do you think is pushing the hydrometer up? What is the hydrometer reading for distilled water?



4). What do you think a hydrometer measures in a given liquid?

5). What type of food, a liquid or a solid, contains more nutrients? Why?

Step Two: Action

Every lab group will be assigned a different liquid to test. Please record your groups' liquid:

- Use the hydrometer to find the density of your group's testing liquid
- Obtain a chem-plate. You will be using these wells to test the nutrient values of the "Mystery Liquid" and the liquid assigned to your group.
- Using the techniques learned previously, test your drink for the presence of a particular nutrient and record. Use an eyedropper to place your testing liquid into the chemplate well. Carefully add one drop of the indicator solution (Biuret- protein). Record the color change. DO NOT MIX UP THE EYE-DROPPERS!
- Use an eye-dropper to obtain a sample of your test liquid. With the eye-dropper, place four drops of the sample onto a square piece of brown paper. After the sample dries, hold the paper up to the light and record your observation. If the paper is "see

through" then fats are present. If the paper remains opaque, then no fats were present.

Step Three: Results

Your groups assigned liquid: ______________________

Well #	Biurets (Protein) Yes	No	Iodine (Starch) Yes	No	Glucose Yes	No	Fats Yes	No

Results of Hydrometer Readings:

Fill in the result that your group determined, then wait until the class discussion to fill out the rest.

Sample liquid	Density g/ml

- Results of the food label . Look at the food label for your group's sample liquid and fill in the table below:

Sample liquid:	
Calories:	
Serving Size:	
Total Fat:	
Sodium:	
Total Carbohydrate:	
Protein:	
Vitamin ____:	
Vitamin ____:	
Mineral ____________:	
Mineral _____________:	

Step Four: Direct Teaching

Take notes in your journals on your teacher's explanations of what you have just seen. Be prepared to discuss your own ideas with the class as well.

Step Five: Journal Writing - Think and write about the following

1. What information does using a hydrometer tell you about that sample liquid?

2. After the class discussion on the hydrometer results, which liquid had the greatest density? What nutrients were found in this liquid (look at the lab results and the label)? Did this result surprise you? Explain.

3. After the class discussion, which sample had the lowest density? Did this result make sense? Why/why not?

4. Do the hydrometer results correspond to the nutrient amounts found within your samples? Explain.

5. It is 11:30 and you are really hungry. For lunch, you reach for a can of Mountain Dew pop. Would this be a good choice as a nutrient source? Why or why not. Would Diet Mountain Dew be a better choice? Explain.

6. What types of nutrients (lab) were found in your liquid sample (the one assigned to your group)? Did these results match up with the food label information? Explain.

5. Specific Gravity Activity

1. What does a hydrometer do?

2. Predict which juice (shown in the back of the room) will have the highest specific gravity.

3. Find the specific gravity of each liquid:

Name of Liquid	Specific Gravity

4. Did the results differ from your prediction? How.

5. Is specific gravity related to a food's nutritional value? Why or why not. (Be sure to look at the food label.)

6. How can this activity be applied to nutrition and liquids?

6. Whose Urine Is It?

Read the following scenario and then proceed to the reflection questions:

You are working as a medical technician in a hospital laboratory. Your specialty is urine. Since you know how to complete a urinalysis with accuracy and precision, you have been asked to sort out a mix-up with the urine samples. It seems that one of your coworkers forgot to label a batch of urine samples and lost the analysis.

It is up to you to reanalyze them and to match the results with the proper patients. The good news is that a complete history record was reported with each patient, and so you are confident that you can straighten everything with the proper scientific investigation.

Patient histories:

Patient #1 is a twenty-one year old female and reports that all is well except that she feels cold a lot. After reviewing her dietary report, the doctor left a note that she has been only eating grapefruit for the past four weeks and is underweight for her height and frame size. The patient has no family history linked to diabetes or to high blood pressure.

What health clues could be present in her urine?

____

Patient #2 is a fifty year old male and claimed that he has been really thirsty for the past couple of months. When asked if he exercised regularly, the patient said no. Also the patient complained of having no energy yet he has been eating more than usual. The dietary report showed years of eating processed foods with high sugar content. A family history of heart disease was established.

What health clues could be present in his urine?

____

Patient #3 is a sixteen-year-old male who has had kidney problems all of his life. His dietary report shows a balance of the major food groups with plenty of water. The patient also exercises regularly. A family history showed high blood pressure.

What health clues could be present in his urine?

____

Step One: Reflection

1. What is the purpose of this laboratory investigation?

2. Which patient above seems to be an easy target for getting type II diabetes? What clues in the patient's history helped you to make this prediction?

3. Explain how urine can be used as an indication of a person's state of health.

Step Two: Action

Urinalysis strip
50 ml beaker with urine sample
Clock with second hand (the one on the wall is fine)
Color strip analyzer

- Obtain a urinalysis strip, color strip analyzer, and 50ml beaker with urine. Record the letter of urine sample obtained

- Note the time and dip the urinalysis strip into the urine sample for 1-2 seconds (ignore the pH readings)

- After one minute, observe the color change in the strip. Use the strip analyzer to record ketone and protein amounts onto the table below.

- After three minutes, observe the color changed for the glucose portion of the test. Use the strip analyzer to record the glucose levels onto the table below.

- Review the patient reports and predict which patient submitted the urine sample that you analyzed

Record the results into your health journal:

Urine sample letter: _______________

Time strip was dipped: _____________

Time after one minute: _____________

Time after three minutes: ___________

Substance testing for:	Color turned:	Amount present:
Ketones		
Proteins		
Glucose		

Step Four: Direct Teaching

Take notes in your health journals on your teacher's explanations of what you have just seen. Be prepared to discuss your ideas with the class as well.

Step Five: Journal Writing

Think and write about the following questions in your health journal. Remember to write in complete sentences.

1. Which patient's urine did you test? Explain how you know.

2. Explain how urine can supply clues to show the health of someone?

3. Using what you have learned by doing this lab, explain how nutrition can affect the body. Provide an example for each situation.

   a) Balanced nutrition:

   b) Unbalanced nutrition:

4. Is it possible for a urine sample to indicate more than one particular problem? How can/can't you tell?

5. If you could run another test to help you decide which urine sample you had, what would it be and why?

6. Write a conclusion statement. Include the following: A) What is the answer to the original question B) Give your best and most truthful reason why you think so C) Write about any questions that you still have even after completing the investigation

Fake Urine Recipe

For a class of thirty students working in pairs, 1 liter of fake urine is required. This 2 liter recipe allows for the manipulation of the stock urine to display various abnormalities which can be measured using urine test strips purchased through Carolina Biological Supply Catalog.

Normal Human Urine - 2 Liters

Albumin powder (egg or bovine)
Creatinine
Distilled water
Potassium chloride
Sodium chloride
Sodium phosphate (monobasic)
Urea

- To 1.5 liters of distilled water add 36.4 g of urea and mix until all the crystals are dissolved.

- Next, add 15.0 g of sodium chloride, 9.0g of potassium chloride and 9.6 g of sodium phosphate; mix until the solution is clear.

- Check the pH to make sure that it is between 5 and 7 for normal urine. If necessary, the pH may be lowered with 1N hydrochloric acid or raised with 1N sodium hydroxide.

- Use a hydrometer to check the specific gravity of the urine. The specific gravity should be within a range of 1.015 to 1.025. If necessary, dilute with water until the desired specific gravity is reached. I used a simple aquarium saltwater hydrometer for this measurement.

This is the storage stock solution of "normal urine solution" and may be kept refrigerated for several weeks or frozen in plastic containers for months. Before use, the stock solution should be warmed to a room temperature. Once ready for use, do the following:

- Add 4.0g of creatinine and100 mg of albumin into the 2 liters of fake urine.

Or

- To have the true "smell and color" affect, add 4.0g of creatinine, 0.4 g of dried yeast extract broth, and a couple of drops of yellow food coloring. Let this mixture age at room temperature for a couple of hours to get the desired smell.

Abnormal Human Urine:

Glycosuria – caused by high levels of glucose due to diabetes mellitus, pregnancy, excessive stress, renal tubular damage and brain damage.

- Add .75 g of glucose to 1 liter of stock urine solution

Proteinuria – caused by high levels of protein the urine and is an indicator of glomerular damage. In the absence of glomerular damage, elevated urine protein may result form excessive exercise, cold exposure and acute abdominal diseases.

- Add 0.3 g of albumin per liter or for severe damage add 1.0 g albumin/liter

Ketonuria – Ketones of various types, which are normal liver metabolites, should not be found in detectable amounts in the urine. Elevated ketone levels are indicative of cold exposure, diabetes mellitus, dietary imbalances and genetically or chemically acquired metabolic abnormalities.

- Add 0.1 g of acetoacetic acid or 1.0 ml undiluted acetone to 1.0 liter of stock solution. I added 4.0 ml of unscented fingernail polish remover to get the desired affect.

7. Which Drink is the Most Nutritious?

Read and analyze the following labels from various drinks.

Compare the following items in each drink:

- Total Fat
- Sodium
- Sugar
- Protein
- Vitamins
- Calories/serving

Calculate how many teaspoons of sugar you are consuming with one serving (Remember that every 11g. sugar = 3 teaspoons sugar).

DRINK A

NUTRITION FACTS
Serving Size 1 cup
Servings Per Container 8

Amount per serving

Calories	120
Total Fat	0g
Sodium	0mg
Potassium	420mg
Total Carbohydrate	29g
Sugars	28g
Protein	1g

Vitamin C	100%
Thiamin	10%
Calcium	2%
Foliate	10%
Phosphorus	2%
Magnesium	6%

DRINK B

NUTRITION FACTS
Serving Size 1 cup
Servings Per Container 32

Amount per serving

Calories	80
Total Fat	0g
Cholesterol	< 5mg
Sodium	125mg
Total Carbohydrate	12g
Sugars	2g
Protein	8g

Vitamin C	2%
Vitamin A	10%
Calcium	30%
Vitamin D	25%

DRINK C

NUTRITION FACTS
Serving Size 8fl oz
Servings Per Container 4

Amount per serving

Calories	70	Total Carbohydrate	19g
Total Fat	0g	Sugars	16g
Sodium	55mg	Protein	0g
Potassium	30mg	Not a significant source of Vitamin A, C, Calcium, or Iron	

LABEL ANALYSIS:

Nutrient	Drink A	Drink B	Drink C
Total Fat (grams)			
Sodium (milligrams)			
Sugar (grams)			
Teaspoons sugar			
Protein (grams)			
Minerals (milligrams)			
Vitamins (mg) (list them for each)			

Using the space below, explain which drink above is the most nutritious. You must have at least four different reasons. Write your answer in complete sentences.

8. Calorimetry Demonstration

Step One: Journal Reflection Questions

1.) What is the purpose of this activity?

2.) What is a calorie?

3.) Which types of foods provide more energy than other foods? Explain why you think this. (Do they contain different types of nutrients?)

4.) Why does the term "empty calories" mean? What type of food qualifies as one with this type of calories?

Step Two: Action

Listen carefully and follow the demonstration. Record the chart and calculations into your health journals as we go through it step by step TOGETHER .

Data Table Food item being tested: ______________________

Trial number:						
Initial mass of food and holder						
Final mass of food and holder						
Mass of food burned						
Mass of can and water						
Mass of empty can						
Mass of heated water						
Final temp. of water						

Initial temp. of water						
Temp. Change						
Calories in food burned						
Calories in 1 gram of food burned						
kilocalories 1 gram of food burned						

Calculations:

Step 1:

calories = Mass of water used x Temp. difference for a given amount of

food burned.

Example: 48.4g x 4.0 C for .2grams of food

Or 193.6 calories in .2grams of food

So....

How much water did we use? __________

What was the temp. change in the water? ____________

Now multiply the two numbers together = _______ for _____grams of food.

Trial 1 results: Trial 2 results: Trial 3 results:

To get kcal or Calories per gram:

Step 2:

Take the answer above and DIVIDE it by the number of grams burned.

Example: $\frac{\text{907.2calories}}{\text{.7grams burned}}$ = 1296 calories/gram

Take this answer and divide by 1000 to convert this value to Calories or kcal.
(MOVE THE DECIMAL THREE PLACES TO THE LEFT.)

Step Two Calculations:

Trial 1 Trial 2: Trial 3:

Step Four: Direct Teaching.

Take any notes given at this time. Record them into your health journals. Wait until after the class discussion to complete the journal response questions.

Step Five: Journal Response Questions

Read each question carefully and then respond in your journal with COMPLETE SENTENCES.

1. Explain how this activity helped you to find out how much energy is found within a given food sample.

2. Think about how the food sample burned. Did it burn fast or slow? Which nutrient do you think is in greatest abundance? (Hint: How did the way it burned indicate the presence of this nutrient?)

3. Why are so many people concerned with how many Calories a given type of food contains? Do the terms, "calories" and "nutritional value" go together? Explain.

4. Explain the difference between a "calorie" and a "Calorie"?

5. Write a conclusion. Include the following A) What is the answer to the question? B) What is the best, most truthful reason why you think so? C) What questions do you still have about the lab demonstration/investigation?

9. Better Cheddar® Label Analysis

1. Look at the food label and think back to your notes. Circle which nutrients are capable of generating energy within the body:

   Fats Sodium Carbohydrates Protein Vitamin A

   How many Calories per gram will carbohydrates provide?

   How many Calories per gram will fats provide?

   How many Calories per gram will proteins provide?

2. Look at the food label. If fats provide 9 Calories per gram, calculate how many calories are fat calories after eating one serving?

3. How many calories are in one serving of Better Cheddars?

4. What percent of this food is fat? (show your work....it will be a division problem)

5. What device can be used to determine the amount of energy found in a food sample? Explain how it works and include a picture.

6. Which type of flour does this cracker contain? How do you know?

7. Which nutrient is in greatest amount when someone consumes or eats this cracker?

8. In your opinion, explain why you think this cracker is or is not a nutritious snack.

APPENDIX D

Student Survey

Nutrition Survey

1. How do you define the word "nutrition"?

2. What makes one food more nutritious than another?

3. Which lab activity sticks out in your mind the most?

4. Does knowledge about nutrition influence the food choices that you make? Explain.

5. Do you think knowledge about nutrition is necessary? Explain.

6. Explain how nutrition can affect your health.

7. What kinds of activities (in school) help you learn the most? Numbering from 1 to 6, rank them 1 being the highest and 6 being the lowest.

   _____ Taking notes
   _____ Writing in a journal
   _____ Completing a lab
   _____ Listening in class
   _____ Discussion with classmates
   _____ Watching a demonstration

8. Which of the previous activities do you find the most fun to do while in class?

9. What do you think about the nutrition unit that we have experienced these past five weeks? Check all that apply.

______ boring

______ interesting and fun

______ needs more notes

______ needs more labs

______ needs less notes

______ needs less labs

10. Which lab activity did you like the most? Why?

Which lab activity did you like the least? Why?

11. After completing this unit do you find the topic of nutrition more interesting or less interesting?

APPENDIX E

UCRHIS Approval

MICHIGAN STATE
UNIVERSITY

October 12, 1999

TO: Merle HEIDEMANN
118 North Kedzie Hall

RE: IRB#**99-615** CATEGORY: 1-A

APPROVAL DATE: October 12, 1999

TITLE: USING LABORATORY EXPERIENCES TO TEACH A NUTRITION UNIT TO 7TH GRADE STUDENTS

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the **UCRIHS approved this project.**

RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.
REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.
PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at 517 355-2180 or via email: UCRIHS@pilot.msu.edu. Please note that all UCRIHS forms are located on the web: http://www.msu.edu/unit/vprgs/UCRIHS/

Sincerely,

David E. Wright

David E. Wright, Ph.D.
DEW: bd
cc: Heather Bradway

OFFICE OF
RESEARCH AND GRADUATE STUDIES

University Committee on Research Involving Human Subjects (UCRIHS)

Michigan State University
246 Administration Building
East Lansing, Michigan
48824-1046
517/355-2180
FAX 517/353-2976

Parental/Student Consent Form

TO: The parents/guardians of seventh grade students
FROM: Mrs. Bradway (Health teacher)
RE: Requesting permission to use student's work in a Master's thesis paper

For the past three years I have been fortunate enough to be spending the summers working on a Master's of Science degree which focuses on current biological laboratory techniques in both molecular biology and in ecology. This learning experience has helped me create a health unit on nutrition, which I hope, can empower students to make good choices about food.

To have a sound thesis I need to collect data on the amount of knowledge gained by each student during the nutrition unit. This unit will last approximately four weeks. The data needs to come from the student's who will be participating in the Health block class this year. The purpose of this letter is to seek your permission to use your son or daughter's confidential scores and responses in my study. Your child's pretest and posttest scores will be statistically analyzed to indicate whether or not the unit was effective. Also, some homework responses may be quoted. I want to personally assure you that in the thesis, your child's name will in no way be associated with any of her/his scores or written responses. The data collection process will be virtually unnoticeable and will not effect the students in any way. Your privacy will be protected to the maximum extent allowable by law.

Mr. Stimac, the 7th grade Life Science teacher, will distribute and collect this form from your son or daughter. This is to ensure anonymity about your child's participation or withdrawal until after the grades for the Heath block courses have been determined. If you or your child has any questions about this study, call me at the middle school at 487-5923. I want to indicate that a withdrawal in no way exempts the student from doing the same work as everyone else, it just means that I will be unable to use his/her data in my thesis.

Thank you for your time and I hope to see you at parent-teacher conferences in November.

Sincerely,

Mrs. Heather Bradway
Hancock Middle School
7th Grade Health teacher

_____ I give Mrs. Bradway my permission to use my data collected from the nutrition unit. I understand that Mrs. Bradway will not use my name and that all my student data will remain confidential.

_____ I do not wish for Mrs. Bradway to use my data in her thesis. I understand I will not be penalized for choosing to withhold my results.

______________________________ ____________
Student Signature Date

______________________________ ____________
Parent or Guardian Signature Date