THE UNIVERSITY OF CALGARY

COMPUTER ASSISTED INSTRUCTION IN THE TEACHING OF NUTRITION

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

CALGARY, ALBERTA

AUGUST, 1986

ISBN Ø-315-32674-3

THE UNIVERSITY OF CALGARY

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "COMPUTER ASSISTED INSTRUCTION IN THE TEACHING OF NUTRITION" submitted by Linda Lee Carver in partial fulfillment of the requirements for the degree of Master of Science.

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ABSTRACT

Research has shown that a large proportion of the Canadian population is not consuming nutritionally adequate meals. Nutrition Canada suggests that this problem might be addressed by employing innovative methods to teach nutrition.

This study examined the effectiveness of using computer assisted instruction (CAI) as a method for teaching two nutrition concepts. A set of computer programs was developed to teach both menu planning based on the four food groups, and the five nutrient groups including their functions and food sources.

An empirical study was then conducted. The subjects were selected from Grade Nine Home Economics students in a rural junior/senior high school. The control group received instruction by a traditional method which included lectures and filmstrips. The treatment group received CAI. The achievement level and attitude in each group was objectively measured by pre- and post-testing. Statistical analyses were performed on these test results to determine if CAI was as effective as traditional instruction in teaching the two nutrition concepts.

The results showed that both the treatment and control groups attained the same level of achievement.

Based on this study, it was concluded that CAI was no less effective than traditional instruction in teaching these two concepts in nutrition, and the CAI method required less time.

The findings of the study indicate that further research should examine the use of CAI to teach other aspects of nutrition.

ACKNOWLEDGEMENTS

I wish to thank Dr. H. J. Hallworth and Professor Ann Brebner for their support and encouragement during my studies. In particular, I would like to thank Dr. Hallworth for his guidance and helpful comments during the completion of this thesis. I appreciate the considerable time he has volunteered.

A very special thank you to my husband Bob and daughter Jennifer who provided the support when it was needed and regarded this as an opportunity to become better acquainted.

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INTRODUCTION

Rationale for the Study

Recent studies have shown that the Canadian population is not obtaining a nutritionally adequate daily diet. Nutrition Canada conducted one of the most comprehensive nutritional studies ever attempted. The study took over two years to complete. It was started in September 1970 and completed in December 1972. The study entailed gathering information from medical and dental examinations as well as dietary interviews of nineteen thousand individuals. From the data obtained the experts were able to compile an accurate evaluation of the nutritional status of the Canadian population.

The results obtained are summarized by age groups in Tables 1, 2, and 3. These tables indicate the percentages of each age group that are consuming inadequate amounts of specified nutrients.

Previously, the U.S. Department of Agriculture 1965-1966 Household Consumption Survey had revealed a similar situation in the United States. The survey showed that: the number of individuals whose diets met the nutritional requirements dropped from 60% percent in 1955 to 50% in 1965; and the number of individuals whose diets

TABLE 1

PERCENT OF INDIVIDUALS (AGES 0 TO 19 YEARS) WITH INADEQUATE INTAKE OF NUTRIENTS

NUTRIENT	GROUP			
	CHILDREN 0–4	CHILDREN 5–9	GIRLS 10–19	BOYS 10–19
PROTEIN	3%	3%	14%	6%
IRON	44%	36%	78%	36%
CALCIUM	26%	44%	62%	50%
VITAMIN A	10%	18%	48%	29%
VITAMIN C	11%	15%	18%	14%
THIAMIN	16%	23%	38%	28%
RIBOFLAVIN	5%	10%	32%	22%
NIACIN	2%	2%	11%	3%

TABLE 2

PERCENT OF INDIVIDUALS (AGES 20 TO 64 YEARS)
WITH INADEQUATE INTAKE OF NUTRIENTS

NUTRIENT	GROUP			
	FEMALES 20-39	MALES 20-39	FEMALES 40-64	MALES 40-64
PROTEIN	18%	9%	26%	13%
IRON	76%	16%	76%	18%
CALCIUM	42%	22%	44%	23%
VITAMIN A	47%	27%	55%	30%
VITAMIN C	21%	15%	16%	14%
THIAMIN	48%	42%	49%	40%
RIBOFLAVIN	42%	32%	49%	30%
NIACIN	9%	2%	11%	5%

TABLE 3

PERCENT OF INDIVIDUALS (AGES 65 YEARS AND OVER) WITH INADEQUATE INTAKE OF NUTRIENTS

NUTRIENT	GROUP	
	FEMALES	MALES
PROTEIN	27%	38%
IRON	35%	56%
CALCIUM	32%	48%
VITAMIN A	47%	54%
VITAMIN C	17%	13%
THIAMIN	41%	53%
RIBOFLAVIN	41%	48%
NIACIN	9%	19%

contained less than two-thirds of the recommended dietary allowances increased from fifteen to twenty percent during this period.

Parish (1971) claimed that our nutritional status has decreased because of the following changes in our eating habits: 1)people raise very little of their own food compared to 30 years ago; 2)people prepare less food at home; 3)snacking has increased as a general food habit and people prefer the snack to be a convenience food; 4)people eat out at restaurants more often; 5)more people are skipping meals; 6)convenience foods which people prefer are particularily low in Vitamin C and A as a result of processing; 7)more mothers have full-time jobs outside of the home, thus, they have less time for cooking and more money available; and 8)more parents are not preparing breakfast for children who claim they are "not hungry".

One of the recommendations from the Nutrition Canada Survey was that many of the current nutrition problems could be reduced by increasing the consumers' level of knowledge of the nutritional principles of meal planning. This idea was supported in White's article (1976) in which he quoted the Pillsbury Baseline Study. This study indicated that less than fifty percent of the women surveyed could not define a balanced diet. White went on to suggest that nutrition education was essential in primary and secondary schools in order to prepare students

for their roles as adult consumers responsible for purchasing food for their own families.

The Department of Agriculture is currently running a nutrition program in some of the elementary schools in Alberta. The main objectives of this program are to upgrade the nutritional status of children and to educate students in the basic principles of nutrition. The concepts covered are targeted at the elementary level and involve the four basic food groups. The students are given different snacks to try. While they are eating, the teacher explains the food groups and identifies the particular group to which the snack they are eating belongs. However, the concept of menu planning is not introduced.

In Grade Nine Home Economics the students are introduced to menu planning. Students are taught to plan meals that meet the requirements of Canada's Food Guide (Department of Health and Welfare [DHW], 1982). A prerequiste to teaching this concept is that students must be familiar with the four food groups.

Since not all the elementary schools are able to offer the nutrition program, some junior high school students are not familiar with the concept of the four food groups. Therefore, in junior high Home Economics classes although there may be a group of students who only need to review this concept, another group of students may

need to have the concept taught before proceeding to the more advanced concepts involved in menu planning.

Once junior high students are familiar with the four food groups and can plan and evaluate a menu that meets the requirements of the Canadian food guide, they are then introduced to the five nutrient groups. However, it is not until the senior high level that students evaluate and plan menus using these nutrient groups, i.e., evaluate menus using the Recommended Dietary Allowances (RDA).

The teaching of menu planning at the junior high level tends to be done in a lecture format. In addition, filmstrips and other audio-visual aids may be used. If students are not involved already in menu planning at home, they may not be very motivated to absorb the instruction in this area. Therefore learning in a traditional format may be compromised because of the home environment.

Nutrition Canada suggests that imaginative approaches be used in the development of effective nutrition education programs. CAI could be one of the new approaches used to improve nutrition education. As Hallworth and Brebner (1980) stated in their report to Alberta Education, CAI will allow the student more individual attention, the student will learn more quickly and effectively, and the student will have a more positive attitude toward learning.

Purpose of the Study

The purpose of this study, therefore, was to develop a CAI program to teach the classification of foods into the food and nutrient groups, and menu planning skills. Further, the purpose was to test the application of this CAI program to determine if students could learn these nutrition concepts from a computer program as well as they would from the traditional method.

CHAPTER II

REVIEW OF THE LITERATURE AND A SURVEY OF THE AVAILABLE SOFTWARE

Introduction

There has been very little published research on the use of CAI, at the junior high level, to teach menu planning based on the four food groups. The review of the literature will be divided into two parts: a general section which examines the application of CAI in other subject areas; and a specific section which examines the application of CAI in nutrition education.

Application of CAI in Other Subjects

According to the literature, CAI can be a very effective method of teaching. A number of advantages of CAI have been identified in the literature.

One advantage is that the student receives immediate feedback. Jeldon (1982) found that this factor kept the student interested in the program. Wrong answers are corrected immediately, hence, they are not allowed to become established.

Jeldon (1982) also found that CAI allows the student to work at his/her own speed. His study indicated that students preferred to have the power to control their own rate of progress through the lesson. Thus a student is

permitted to review a topic before proceeding to new work. Similarly the student is not held back by other students who are having trouble. When Ryba (1982) interviewed students who had been involved with CAI nearly fifty per cent of the students indicated that they preferred the level of self control CAI provided.

CAI also reduces student inhibitions. It eliminates the fear of giving incorrect answers or making mistakes. The student can honestly input his/her own answer and have an evaluation completed without having to reveal his/her answer to the other students or the teacher. Ryba states:

> "the relatively impersonal nature of a computer can provide direct feedback without triggering negative perceptions of failure that often accompany more conventional interpersonal forms of instruction that tend to have an adverse effect on performance". (1982)

Apter's (1968) studies found that CAI necessitates constant student interaction with the computer program, which is desirable. Because the student is not required to wait to answer or ask a question, his/her mind is not as likely to wander during the lesson. "A common observation is that students using CAI programs exhibit an increased attention span" (Hallworth and Brebner, 1980). Jeldon (1982) suggests that no more than three frames be

shown without a student response being required. Carew, Elvin, Yon, and Alster, (1984) found that questions within the program hold a student's attention better than only written statements appearing on the screen.

Another advantage is that CAI permits individualized instruction. For example, it is possible to identify a student's needs and background. Branches and loops can be used to provide remedial work for slow learners while at the same time permitting branching forward for students who have a prior knowledge of the subject (Jeldon, 1982; Apter, 1968; Dyer, 1972). Apter summarizes this by stating:

> "the student is in a sense given personal tuition in much the same way as he would be if he had a personal tutor: in those parts of a subject in which he has particular difficulty he is given extra practice and training, and in those parts of the subject in which he is proficient in a short time, he is not bored with needless repetition." (Apter, 1968)

CAI facilitates the concept of mastery learning as the student must master each step before he/she can proceed to the next level (Apter, 1968).

It has also been found that CAI programs are better planned than lessons prepared by a full-time teacher. This is attributed to the lack of preparation time

available to individual teachers (Apter, 1968; McMurray and Hoover, 1984).

The impersonal nature of a computer program provides further advantages (McMurray and Hoover, 1984; Apter, 1968; Dyer, 1972). For example, "information can be standardized and free from biases such as facial expressions and tones of voice" (McMurray and Hoover, 1984). "If we wished to be flippant we could say that teaching machines are tireless and never lose their tempers or patience" (Apter, 1968).

Another advantage is that CAI can be used to simulate experiences that are otherwise too expensive or impossible to produce using traditional teaching methods (McMurray and Hoover, 1984). Thus students can repeat these experiences and gain competency in coping with real life situations without excessive costs or dangers. Through simulations and games a small school may supplement its curriculum without increasing its budget for expert personnel or specialized equipment (Moshell, 1982).

CAI seems to produce a positive attitude towards learning (Hallworth and Brebner, 1980; Carrier, 1979; Charp, 1980). This could be attributed to a number of factors such as: novelty, gaming capabilities of the computer, self-pacing, and the absence of fear of being wrong or ridiculed (McMurray and Hoover, 1984).

Thomas (1979) has shown that, compared to traditional methods, CAI requires less time to teach a concept. Hallworth and Brebner cite the following studies which have shown that equal or better achievment was obtained in less time with the use of CAI:

> "for a variety of elementary school CAI projects (Edwards et al, 1975); for fourth grade to ninth grade mathemathics (Johnson, 1974,; Cranford, 1976; Jacobson and Thompson, 1975); for typewriting (Wolcott, 1976); for industrial arts (Diedrick and Thomas, 1977); for accounting (Solomon, 1974); and for biology (Arsenty, 1971)." (Hallworth and Brebner, 1980)

Besides reducing the time to teach a concept it has also been shown that CAI can produce higher levels of achievement (Jacobs et al, 1966). Hallworth and Brebner cite a survey done by Thomas (1979), which indicates:

> "positive effects on achievement in mathematics (Bukoski and Korotkin, 1975; Taylor et al, 1972; Wright, 1977); biology (Broderick, 1974); problem solving in physics (Hughes, 1974); algebra (Morgan and Richardson, 1974); and reading (Fricke, 1976)." (Hallworth and Brebner, 1980)

Application of CAI in Nutrition Education

McMurray and Hoover (1984) list three advantages for using CAI specifically in nutrition education. The first advantage is that it allows for better use of time by both professionals and students. Teachers can be freed from repetitious instruction and paper work. Thus they will have more time for individualized personal instruction.

The second advantage is that the student is less dependent upon the teacher as a source of information. The computer program can provide nutritional information, thus even if the instructor is not available, the student can obtain the desired information.

The third advantage that they list is one of economic feasibility. The cost of computers is decreasing while the cost of a professional's time is increasing, thus computers are becoming more economically practical.

Nutritional Analysis

In the nutrition area, the computer has been used mainly for the nutrient analysis of an individual's diet. Two advantages for using the computer for nutrient analysis have been suggested. The first of these is that a more comprehensive menu analysis is provided with less labour input (Brisbane, 1964). For this reason nutrient analysis done with a computer is less expensive than the analysis done manually (Flook and Alford, 1974). The

second advantage is that a more precise analysis is obtained using a computer program (Brisbane, 1964).

Several potential problems have been noted regarding the application of CAI to nutritional analysis.

In most of the programs only the consumed amounts of each nutrient are presented in the results, along with a comparison to the Recommended Dietary Allowances (RDA). There is no interpretation of the results included. The interpretation is left to the software user. Thus, if the user is not familiar with the meaning and the appropriate uses of the RDA, it may lead to misinterpretations.

CAI is intended to complement rather than replace a qualified professional. Rogan and Yu (1984) have a fear of "nutrition quackery". Health food stores, spas, and nontraditionally educated "nutrition consultants" may misuse software packages in order to create a demand for their own services.

There is also concern with the validity of the results. A number of factors influence the nutrient value of foods, i.e., cooking temperature, cooking method, and recipe ingredients. As a result, the nutrient content values may not be accurate. Further, results presented to the user are usually expressed to the nearest hundredth or thousandth of a milligram. This implies levels of significance which are of questionable validity.

Nutrient Analysis for a Classroom

Murphy, King, and Calloway suggest that a computerized diet analysis system can serve a number of purposes in a classroom:

> "It is useful for teaching food composition, for designing diets that meet specific criteria, for promoting awareness of the nutritional consequences of food intake habits, as well as for introducing students to some basic computer techniques." (1984)

When choosing a diet analysis system there are a number of factors to consider. Murphy et al (1984) have identified four features. The first of these is the type and number of food items in the nutrient data base. They suggest that 200 to 300 foods is usually adequate. It is necessary to validate the nutrient values in the data base by referring to a reliable source.

The second factor to consider is how the food items are entered into the system. The student must enter the name or number of each food item and the amount consumed. A system that requires the least amount of time and facilitates error detection and correction while completing this task is most desirable.

Commonly, a diet analysis uses a coding system to enter the food items. Unfortunately there is no universal

coding process available. Their studies found that a number of software packages developed in the United States are using the food codes published in the United States Department of Agriculture's Agriculture Handbook No. 8 (Watt and Merrill, 1963).

Murphy et al found that the following four methods are being used to enter the food items. The first method involves transcribing codes from a published table. They found that this procedure worked well with college students because these tables are used in other courses. In the second method a coding manual is created utilizing a smaller data base. The students must also be supplied with substitution guidelines because of the smaller data base. In the third method the student enters the name of the food item, then the program prompts the student for more detail. In the fourth method being used, the program displays a number of tables, then the student selects the appropriate food item from these tables.

The last two methods require a video display terminal or microcomputer, which has economic implications for their implementation. However, according to Murphy et al the students found it easier to enter dietary data using the third and fourth methods. They also found that the students preferred to work with traditional household measures which use cup, teaspoon, etc. rather than the

International System of Units (SI) which uses kilogram, litre, etc. Since nutrient tables commonly employ SI units, students must weigh serving portions on a SI scale to enter the amounts accurately.

The results of the nutrient analysis is the third factor to consider. The nutrient analysis results should include, at the minimum, a total intake of all nutrients, and the results should also list the following as other desirable features:

> ". a display of the nutrient content of each food item in the diet
> . a subtotal of the nutrient content of each meal
> . a percent of RDA (or other dietary standard) for various nutrients, according to the user's age, sex, and size
> . an indication of which foods are contributing large amounts of a component of concern (such as salt, cholesterol, fiber, etc.)
> . a display of various other calculated figures, such as calcium to phosphorus ratio or polyunsaturated fat to saturated fat ratio." (Murphy et al, 1984)

If the display of the results obtained from the analysis appears to be correct to the student, there should be an option to obtain a hard copy. If the student wishes there should also be a procedure to save the list of food items and results so that modifications can be made, if desired, at a later date.

Another feature that is desirable is a method to modify the nutrient data base. Thus foods can be added to, or subtracted from, the list so that the foods indigenous to the area can be included. Also a facility for the modification of nutrient values for foods is advantageous.

CAI can provide a number of features that are desirable for the nutritional analysis of diets. These same features could also be employed to develop programs concerned with other aspects of nutrition education.

Authorship of Nutrition Educational Software

There are several diet analysis systems available, but there is a lack of software that can be used to teach other topics in nutrition (Ries et al, 1984). Nutritional educators are the people best suited to write the text for this type of software. This is confirmed by Carew et al (1984) who found that CAI is more successful if the text is written by the instructor rather than by another individual creating the text based on tapes or notes taken during the lectures in nutrition classes. Most instructors are reluctant to become involved in the writing of software because they feel that they lack sufficient programming language skills.

Programming language skills are not a prerequiste for producing good software. As Ries et al (1984) point out

the nutritional experts must plan the lesson, including the text, student interaction, and formatting. Then they can collaborate with an experienced programmer to do the actual programming. The involvement of the educators is important to ensure both adherence to educational objectives and content accuracy (Njus et al, 1984).

Review of Software

There are two reasons for reviewing the available software. The first is to determine if there is existing software appropriate for teaching menu planning based on the four food groups. The second is to examine the instructional designs that are already being used to teach this concept.

Nutrient Analysis Software Packages

A number of CAI programs have been developed for nutrient analysis. Three of these programs were available for use.

Diet Detective (1978) was developed by Action B.C. in Vancouver but is now operated by Agriculture Alberta in Edmonton. In this program, the student fills out a form which describes the student's body build and physical activity, in addition to what (s)he consumed for one day. The completed forms plus five dollars per form are sent to Edmonton for computer analysis. In approximately three to four weeks the students receive back a print-out providing

information on: calorie intake, food groups, a breakdown on the nutrient content of their menu, and a list of recommendations to improve their diet. This program is not suitable for the junior high level because the analysis deals more specifically with the nutrient groups rather than food groups.

The Pillsbury Company has developed a program called Eat Smart (1981). The function of this program is diet analysis. The student keeps a record of the food (s)he consumes in one day. The data must be coded, with the assistance of a worksheet, and then the code numbers are entered via the keyboard. The results are available either on the screen or on the printer. The results of the analysis include: a comparison to the United States Recommended Dietary Allowances (USRDA), total sodium, cholesterol, and the percentage of calories from fats. A problem for Canadian users is that the USRDA is different from the Canadian RDA, thus the results would not be appropriate for Canadian users.

Alberta Agriculture distributes a program called Diet Detective Junior (Hills, 1982). This program is designed to analyse the food consumption for one day. The student is allowed to enter food items for breakfast, lunch, supper and a snack. On the screen, there are nineteen food items displayed for each meal. The user is

to indicate how many servings of each food item they consumed for that particular meal. The limited data base may necessitate that the user make a number of substitutions in order to enter what (s)he has consumed. Upon completion of entering food items the user is presented with the number of calories per meal, as well as the amount of protein, iron, and vitamin C in the diet. The program also compares the results to the Canadian Dietary Standard, makes suggestions for improving the diet, and directs the user to local resources for more information or assistance.

Mayer (1984) makes the following criticisms of the program: the program uses nutritional values from 1975, which are now considered obsolete, the list of foods for each meal is not consistent, and the recommendations assume a moderate activity level, but the program and documentation do not define this level. She suggests that the program be used for nutrition awareness rather than nutrition education.

General Nutrition Education Software Packages

There are few nutrition education programs concerned with topics other than nutrient analysis. Six of these were available to the researcher.

A program developed by Alvina Hills has the following objectives:

> "1) identify the four food groups outlined in Canada's Food Guide,
> 2) place specific foods into their correct food group,
> 3) identify those foods that do not belong to any of the four food groups and are classified as 'extra' foods." (1981)

This program was designed to teach one of the lessons in the nutrition program at the elementary level, specifically at Grade Six. It consists of three parts. Part one introduces Canada's Food Guide (DHW, 1982) as well as the nutrients that are available in each group. Part two provides the user with a list of specific foods found in each food group. Part three requires the student to match foods to the appropriate food group. A data base of 65 food items is used to generate the questions.

Action B.C. has developed a disk which contains four games: Spellbound, Hangman, Balance Your Breakfast, and Weight War I (1982).

Spellbound (Action B.C., 1982) is similar to a commonly played word game. The computer program displays a name of a fruit or vegetable (Kale is the first vegetable name displayed each time the program is run). The student then enters the name of a fruit or vegetable that starts with the last letter of the displayed name. The computer program wins if the student is unable to enter an appropriate name. However, there is no time

limit. The program is very slow with the disk drive running approximately 30 or 40 seconds after each entry.

The objective of Hangman (Action B.C., 1982) is to identify unknown nutrients. A blank representing each letter in the mystery nutrient's name is displayed. The student must guess the letters that are required to spell the name of the nutrient. After 10 incorrect guesses the student is 'hanged'. The unknown nutrient is randomly selected from a data base of 22 nutrients. At the end of the game the nutrient's functions and food sources are displayed on the screen. A potential problem is that the program will not always accept the input. For example, the computer program will tell the user three times that 'p' is not in the word. On the fourth attempt it will finally accept it. Another problem is that to identify some of these nutrients the student would require a very extensive knowledge of nutrition. In fact, most senior high students would have difficulty guessing some of the nutrients included in the data base.

Balance Your Diet (Action B.C., 1982) is a program that gives the student an opportunity to plan a breakfast. The program begins with a short tutorial, after which the student enters his/her breakfast food choices. The student's breakfast is evaluated in terms of meeting one-third of the daily requirements of the RDA. The

results are presented in pictorial form utilizing a balance. The left hand side of the balance represents the evaluation of the student's breakfast. If the balance pans are level then the breakfast was nutritionally acceptable. If the left hand balance pan is lower then the right hand pan, then the breakfast was judged deficient. Conversely, if the right hand pan is below the left hand pan then the breakfast was judged as excessive. There appears to be a 'bug' in the program because when a nutritionally adequate breakfast, based on the tutorial, is entered the pans on the scale do not appear balanced on the screen. Other shortcomings include the small data base of food items and there is no provision at any point for remediation.

Weight War I (Action B.C., 1982) is a game between 'Mr. Fat' and the student. The student is presented with a physical activity. (S)he must select, from a group of three, a food that provides sufficient energy and nutrients to perform the activity. Unfortunately the right answer is always the second choice. The program's graphics are displayed on the screen very slowly.

Aquarious Publishers, Inc. has produced a program titled Eating For Good Health (1982) which presents a screen of text, followed by a question with four possible answers. If the student enters the wrong answer

remediation is provided and the student is allowed to try again. There is no limit on the number of tries per question, thus there is no way of controlling for lingering. In the extreme, the student could remain on the same question indefinitely. The program does not appear to have any structured educational objectives. For example the text upon which the questions are based provides little useful information.

Conclusion

Although there has been little specific research on the applications of CAI in nutrition education, it has been shown that menu evaluation by computer is very useful in a classroom situation. Generally research indicates that CAI can be an effective teaching methodology. Thus it is suggested that CAI may be one of the innovative methods for teaching nutrition.

While examining the available software it was apparent that there was no existing program that could be used for the experiment. The programs available are concerned with nutrient analysis, i.e., evaluating menus using the nutrient groups. This is not appropriate at the junior high level because the students are to use the four food groups, rather than the nutrient groups, for evaluating menus. Therefore, it was necessary to develop

a set of programs to teach the four food groups, the five nutrient groups, and menu planning based on the food groups.

CHAPTER III

COURSEWARE DESCRIPTION

Development of Materials

At the junior high level the students are introduced to menu planning. Students are taught to plan meals that meet the requirements of Canada's Food Guide (DHW, 1982). A prerequisite to teaching this concept is student familiarity with the four food groups.

As indicated earlier, since not all elementary schools are able to offer a nutrition program, some junior high school students lack the prerequisite familiarity with the four food groups. Therefore, some students need only to review this concept while other students need to be taught this concept before proceeding to the topic of menu planning.

Once all students are familiar with the four food groups and can plan and evaluate a menu that meets the requirements of the Canadian Food Guide, they are introduced to the five nutrient groups. It is not until senior high level that students evaluate and plan menus using the nutrient groups, i.e., evaluate menus using the Recommended Dietary Allowances (RDA).

A set of computer programs was developed by the researcher to provide diagnostic assessment and remedial

instruction on the four food groups. Developmental testing was done by grade nine students at a junior/senior high school.

As a result of the enthusiatic response by the students to this new approach, a second set of programs was developed. These programs cover menu planning and identification of the five major nutrient groups. Developmental testing was again done by the grade nine students at a junior/senior high school.

Computer Hardware Used

The program was developed for use on either the Apple II or the Apple IIE. The computer configuration consisted of a single disk drive, central processing unit (CPU) with 64 K of memory, and a cathode ray tube (CRT) display. The screen had the capability to display 24 lines of 40 characters. All the responses were entered via the keyboard. The graphic capability of the system was very difficult to access, thus, only limited graphics were incorporated into the program.

In the experiment, two Apple IIEs, a Bell and Howell, and a Franklin Ace were used by the students. The Bell and Howell and the Franklin Ace are Apple clones. Unfortunately this was the only computer hardware available, thus the sample groups were limited in size.

Description of Computer Courseware

The computer program was writtem in the BASIC programming language. It was based on the nutrition unit of the Grade Nine Home Economics course.

The objectives of this computer program are that the student will:

1) identify the four food groups defined in the Canadian Food Guide;
2) list the requirements of each of these food groups;
3) identify the foods found in each of the food groups;
4) apply the above knowledge to plan a menu for one day that meets the requirements of the Canadian Food Guide;
5) apply the above knowledge to plan a menu for seven days;
6) be able to identify the five nutrient groups; and
7) be able to list one food that belongs to each of the nutrient groups.

The program consists of three lessons. Due to the limited memory capacity of the disk, three disks had to be used for the courseware. Lesson one began with a tutorial which introduced the four food groups and the foods that belonged to each of the groups. This was followed by a drill and practice which required placing a

food item into the proper food group. Unless a student had this ability (s)he could not use the Canadian Food Guide to evaluate the nutritional value of a meal. At the beginning of the drill the student was presented with the instructions. Then the student was asked a question. The questions were randomly drawn from one of four subroutines. Each of these subroutines dealt with one of the four food groups. If the student answered incorrectly, then (s)he was given a hint after which (s)he was allowed to try again. If the student again answered incorrectly, then (s)he was given the correct answer, following which (s)he was presented with the next question. Each drill consisted of 20 randomly selected questions. The student was required to complete all 20 questions and achieve a minimum of 16 correct. This provided a drill on all four of the food groups, thus preventing the possibility of only two or three of the food groups being covered adequately as could happen in a shorter drill. Until this mastery level was achieved the student was required to repeat the drill and practice section. Each student's results were recorded in a file.

The second section of the program began with a mastery assessment which determined where the student should commence further instruction. The assessment tool consisted of nine questions which reviewed the foods that belong in the food groups as well as the daily

requirements of each group. If the student had more than five errors (s)he was transferred back to the drill and practice. If the student had between one and five errors (s)he was routed to a tutorial that, in general, reviewed the four food groups covered in the first section. Specifically, it introduced Canada's Food Guide (DHW, 1982) and listed the requirements of each of the food groups. Following this the student moved on to a section about menu planning. If a student made no errors (s)he by-passed the tutorial and moved directly to the section concerned with menu planning .

At the beginning of the menu planning section instruction was given on how to evaluate a menu by utilizing the Canadian Food Guide. The students were given a worksheet which served as an aide-memoire to help them evaluate the menus in the remaining part of the program.

The instuctions for the evaluating process consisted of presenting a menu, and directing the student through a step-by-step evaluation of the menu. Following this a second menu was displayed and the student was asked to evaluate it using the worksheet provided. If the menu evaluation was incorrect remediation was provided. There was a total of seven different menus. After the sample menu, the remaining menus which the student was to evaluate were displayed in random order.

When the student evaluated two consecutive menus correctly (s)he was transferred to the following section, after the results were recorded in the student's file. If the student did not meet the mastery requirement, of evaluating two consecutive menus correctly, (s)he received a message to see the teacher, the results were recorded in the student's file, and the program was terminated. The teacher could then examine the student's worksheet and results to determine why (s)he was having difficulty. If the difficulty was related to placing foods into their proper food group the student could repeat the drill and practice.

The next portion of the program instructed the student to: ask the teacher for a copy of the food list, draw up a menu for one day, and return to the computer with the completed menu plan and the food list and begin the second part of lesson one.

When the student returned to the computer the program checked to see if the file containing the student's results was on the disk. If it was not, an error message was displayed and the program was terminated. This precluded the possibility of the student completing the lesson before receiving an error message that the file was not on the disk.

Following this, the student was presented with instructions on how to enter the menu. A sample menu was

displayed and the student was required to decide if (s)he wished the directions repeated or to continue the lesson.

Four files were read into arrays and used to evaluate the student's menu. Each array was for one food group. Additional food items could be added to each file. Thus, if the program was used in different geographical locations, new food items indigenous to that area could be added to the file.

After the name of the meal was printed, the student could input the food items (s)he desired. The program then checked to see if each item was in the memory. If the item was not, the student received an error message and was instructed to try again. The student signaled (s)he had finished that particular meal by typing 'F'.

Each daily menu consisted of breakfast, lunch, supper, and a snack. At the end of the day both the total number of servings in each of the food groups as well as the recommended number of servings from each group were displayed. Using these results the student was given a brief evaluation of the menu. The student's results were recorded on the disk.

Following this the student was presented with the instructions for the next assignment which was to plan a menu for seven days. The student was cautioned that during the week (s)he might run into unexpected situations which might cause a meal to be missed. This concluded the

first lesson at the computer.

In the second lesson the student spent the first half of the class preparing a menu for the seven days. The last half of the class was spent entering the seven daily menus into the computer. These menus were computer evaluated and the results were displayed to the student and stored in a file.

The program to enter the seven daily menus began by reviewing the procedure to enter the menu. The procedure used was the same as that for entering the menu for one day. Although each normal day consists of breakfast, lunch, supper, and a snack, the student was cautioned that (s)he might miss breakfast, lunch, or supper. This feature was incorporated to force the student to revise the menu for that day to ensure that the student obtained the requirements of Canada's Food Guide (DHW, 1982). This made the assignment more realistic. A random number was used to determine on which day and what meal the student would miss. The student was informed which meal (s)he had missed and a specific reason given why this had happened, then the program moved on to the next meal. The program was so designed that, on average, the student missed approximately one meal per week.

Each normal day consisted of breakfast, lunch, supper and a snack. At the end of each day both the total number of servings in each food group and the recommended number

of servings from each group were displayed. At the end of the week a cumulative summary of the daily totals was displayed as well as the average number of servings per group. Using these results the student was given a brief evaluation of his/her menu. The student's results were then recorded in the file.

Lesson three covered the five nutrient groups. This lesson and the students' records for this lesson had to be stored on a second disk because of the constraint imposed by the memory capacity of the disks.

The third lesson introduced the five nutrient groups. Following this there was a tutorial on the types, functions, and food sources of three of the the five nutrient groups: fats, carbohydrates and proteins. Following the tutorial the student was asked if (s)he wished to review or to begin the game. If the choice to review was made, (s)he was instructed to fill out a worksheet on nutrient classification while reviewing.

The second portion of this lesson was in a game format. The student attempted to determine the nutrient from descriptive clues that were provided sequentially as required. The first hint described the function the nutrient plays in the body. The student was then allowed to guess the name of the nutrient. If the guess was wrong, the next clue listed a food which contained the nutrient. Following the clue the student attempted to

identify the mystery nutrient again. If the response was incorrect, then the correct answer was presented. If the student was able to identify the nutrient (s)he was advanced to the next mystery nutrient.

If the student achieved a score of at least six correct out of seven, (s)he could choose to: repeat the game, advance to the next section, or terminate the program.

If the student did not obtain a score of at least six correct, (s)he could choose to review or repeat the game. If it was the first time the student had reviewed, then (s)he was instructed to fill out the worksheet on nutrient classification while reviewing.

The next section of the lesson provided instruction and practice for the last two of the five basic nutrients, vitamins and minerals. It began with a tutorial on the names, functions, and food sources of six vitamins and four minerals. The vitamins were Vitamin A, C, D, riboflavin, niacin, and thiamin. The minerals were iron, iodine, calcium, and phosphorus.

At the end of the tutorial the students were asked to complete a worksheet in the form of a chart that lists the functions and food sources of the vitamins and minerals. This worksheet was included so that the student had a hard copy to study from for the final examination at the end of the school year. The students could request help from the

computer while completing the worksheet.

Once again a game format was used to provide the students with practice in identifing the various vitamins and minerals. This game was based on a game used by the researcher in the traditional instruction mode. The game consisted of 15 questions. The name of a vitamin or a mineral and a food source or function were displayed. The student was to determine if the two pieces of information matched. If the student answered correctly (s)he received a point. If the student answered incorrectly the computer received the point. At the end of each game the student had a choice of: repeating the game, reviewing vitamins and minerals, or terminating the program. This concluded the student portion of the computer program.

For each student, the results for each lesson were recorded in a separate file named by a combination of the first five letters of the student's last name and the first two letters of the student's first name. The records could be accessed through two programs - both called Student Record. There were two programs because the results were recorded on two separate disks. The results for lessons one and two were recorded on the first disk and the results for lesson three were recorded on the second disk.

The program for examining the students' results from lessons one and two began by displaying a menu allowing

the teacher four options: list the names of students who have started the program; examine a specific student's results; delete a specific student's results; or exit from the program.

The first option opened a file and then displayed the first and last name of each student whose results were on that particular disk.

The second option allowed the teacher to examine a student's results. The student's score on the drill and practice in lesson one was recorded every time the student used the drill. Both the number of questions and the number of correct answers from each of the food groups were available.

The next set of results available included the student's score on the nine questions used to determine the student's mastery level. There was also a record of the number of menus the student had attempted to evaluate and the number evaluated correctly. In addition, the number of errors made while evaluating the menu in the remediation steps was displayed.

The third option allowed the teacher to delete a specific student's file from the disk and delete the student's name from the catalog of students' records available on that particular disk.

The last option allowed the user to exit from the program.

The second Student Record program, dealing with the results from lesson three, was found on the second disk. It began by presenting the same four options found in the first Student Record program. The results that were available included the number of times the student had completed each of the two games and the number of correct answers on each game.

Description of Traditional Instruction

Three eighty-minute lessons were used to teach the concepts involved in menu planning and the five basic nutrient groups.

In the first lesson the students viewed two video tapes that were produced by Alberta Educational Communications Corporation. They are titled Canada's Food Guide (1976) and You're Just a Bunch of Chemicals (1976). While the students were viewing the video tapes, they were to identify the four food groups and the required number of servings for each food group. This was followed by a discussion of the Canadian Food Guide and how it could be used to evaluate menu plans. A copy of the guide was distributed to each student.

The students were instructed to write a menu for one day. This menu was to meet the requirements of the Canadian Food Guide. The menu was evaluated in class by the teacher. Following this the students were instructed to prepare a menu plan for three days for the beginning of

the next class. The number of days in the assignment was traditionally three because of the time required for the teacher to evaluate each of the daily menus.

The second lesson introduced the five basic nutrient groups. The students viewed two filmstrips from The Nutrition Series (1974) developed by McGraw - Hill. The filmstrips were titled Waldo Learns About Nutrition Part I and Part II. The filmstrips describe the functions and food sources of each of the five basic nutrient froups. While viewing the filmstrips the students were to answer questions on a worksheet. The questions were corrected at the end of the filmstrip. Following this, the students, with the help of the teacher, completed the worksheet on nutrient classification. This worksheet provided a summary of the five nutrient groups. When finished the students were allowed to complete Waldo's Crossword Puzzle which is based on the functions and food sources of the five nutrients. This puzzle is also from The Nutrition Series (1974).

The third class period consisted of a review of the nutrient groups. A copy of the Vitamin/Mineral Chart was distributed to each student. This chart lists the functions and food sources for each of the vitamins and minerals. This chart was obtained from The Nutrition Series (1974).

Three games were made available to the students.

These games were used to provide the students with drill and practice on the nutrient groups. Two of the games, Vitamin Concentration and Mineral Concentration, were from The Nutrition Series (1974). These two games are played the same way. All the cards are placed face down on a table. Each student takes a turn turning two cards face up. If the student turns up a related pair (one card that names a food source or tells how it is used in the body and one card that names a mineral or vitamin in the food source), then the student keeps the pair and takes a second turn. If the two cards are not a related pair, the cards are turned face down and the next student takes a turn. The student who has collected the greatest number of related pairs when all the cards are turned up is the winner. The third game was a matching game that the researcher developed. The students were to match the name of the nutrient with a food source it is contained in or a function it performs in the body.

Conclusion

It would be desirable to have a cost-effective, packaged, alternative to the traditional method of teaching the nutrition portion of the Grade Nine Home Economics curriculum. However, it is crucial that this alternative method be as instructionally effective as the traditional method. Intuitively, it would appear that the computer courseware described earlier met the above

criteria. However, this subjective assessment could be confirmed only by objective testing. . . .

CHAPTER IV

THE EXPERIMENT

Introduction

The purpose of the study was to determine the effectiveness of Computer Assisted Instruction (CAI) in the teaching of food groups, nutrient groups, and menu planning to grade nine Home Economics students. An experiment was designed to test the courseware which had been developed by the researcher.

Design of the Experiment

In order to test the effectiveness of this CAI package it was necessary to have two groups. One group, which is referred to as the control group, received traditional instruction as described in Chapter III. The second group, which is referred to as the treatment group, received instruction from the computer program described previously.

The control group received instruction for a fixed duration, specifically, three eighty-minute classes. The treatment group was allowed to leave when they had completed the various sections of the computer program assigned for that particular class period. A record of the amount of time required by each student to complete each section of the program was kept. The time taken was

then used as an additional variable for comparing the groups.

Subjects

The subjects who were the participants in the study were all Grade Nine Home Economics Students in a rural junior/senior high school, and were chosen from a total of 28 students in two classes that attended two eighty-minute Home Economics classes per week.

The treatment group was composed of a total of 12 students. Six students were randomly chosen from each of the two classes. The group consisted of three males and nine females. The sample size was restricted to 12 students because of the lack of available hardware in the school as well as the limited number of Home Economics students.

The control group was obtained from the remaining students. Six students were randomly selected from each of the two classes. Thus the control group consisted of twelve students of which three were males and nine were females. It was only by chance that the male/female composition of both the treatment and control groups was identical.

Table 4 indicates the number of subjects in each group.

TABLE 4

SAMPLE SIZE

	CONTROL GROUP	TREATMENT GROUP
Class 1	6	6
Class 2	6	6
Total	12	12

Measuring Instruments

Both achievment and attitude measuring instruments were used to test the effectiveness of the courseware.

Measure of Achievement

The achievement test, which served as a pre- and post-test, was developed by the researcher as there was no existing appropriate test available to measure the specific objectives taught by the courseware. The test consisted of five questions. The first question asked the student to list the four food groups and the daily requirements of each group. In the second and third questions the student was required to use this knowledge to evaluate existing menus and to develop a menu for one day that met the requirements of Canada's Food Guide (DHW, 1982). The final two questions tested knowledge of the functions and food sources of the five major nutrient groups. There was a total possible score of 28 on the menu planning portion and a total possible score of 26 on the nutrient group portion of the test. The face validity of this test was ensured through consultation with three experts in the Home Economics field.

Attitude Measures

A semantic differential questionnaire based on the 'School Subject Attitude Scales' developed by V. R. Nyberg and S. C. T. Clark of the University of Alberta for Alberta Education was used to measure attitude (1983).

The test consisted of 24 bi-polar descriptive word pairs which were graded on a five point scale. Eight of the pairs were used to assess the evaluation factor, eight pairs were used to determine the usefulness factor, and the last eight pairs were used for measuring the difficulty factor. A school counsellor administered this test in an attempt to reduce faking. The test was adminstered at the beginning and end of the experiment and evaluated by Alberta Education in Edmonton.

The students who used the computer were asked to also complete a computer acceptance questionnaire regarding their attitude toward the use of computers. This questionnaire was modeled on an attitude test used by the Planning Services division of Alberta Education in a study on the utilization of microcomputers in an elementary school learning resource center (1983). The test consisted of five questions. The first three required the student to respond on a five point scale. The last two questions required the student to write sentence answers.

Copies of these tests can be found in the Appendix.

Administration

While the control group received the traditional instruction previously described, the students in the treatment group received instruction from the computer program in another part of the school.

The classes for the control group were taught by an

experienced teacher who has sucessfully taught the Grade Nine Home Economics course for a number of years. Due to administrative constraints and because the teacher was familiar with computers, this teacher also supervised the treatment group. Although both groups were taught simultaneously it was only necessary to provide assistance to the treatment group to access the program. Following this no further help was necessary and the teacher was able to devote full attention to the control group.

The time line in Table 5 was followed.

Research Questions

The main objectives of this research were to answer the following questions:

1)did both groups acquire the skills to develop menus that meet the requirements of the Canadian Food Guide?

2)did both groups learn the food sources and functions of the five nutrient groups?

3)did the treatment group learn more than the group who received "traditional" instruction?

4)did both groups require the same amount of time to obtain these skills and knowledge?

5)did the exposure to CAI have an effect on the students' attitudes?

These research questions were formulated as formal hypothesis as follows.

TABLE 5

TIME LINE FOR THE EXPERIMENT

DATE		TOPIC
CLASS 1	CLASS 2	
FEB. 8	FEB. 10	PRE-TEST AND ATTITUDE TEST
FEB. 13	FEB. 14	LESSON #1
FEB. 20	FEB. 17	LESSON #2
FEB. 22	FEB. 21	LESSON #3
FEB. 29	FEB. 28	POST-TEST AND ATTITUDE TEST

Main Hypotheses

1)There will be no significant difference between the mean pre-test scores, as measured by the achievement test, for the control and the treatment groups.

2)There will be no significant difference between the mean pre- and post-test scores, as measured by the achievement test, for either the control or the treatment group.

3)There will be no significant difference between the mean post-test scores, as measured by the achievement test, for the control and the treatment groups.

4)There will be no significant difference between the mean pre-test scores, as measured by the attitude test, for the control and the treatment groups.

5)There will be no significant difference between the mean pre- and post-test scores, as measured by the attitude test, for either the control or the treatment group.

6)There will be no significant difference between the mean post-test scores, as measured by the attitude test, for the control and the treatment groups.

Notwithstanding the random selection process for determining the groups, hypotheses one and four were included as a safeguard.

Secondary Hypothesis

There will be no significant difference in the amount of time required by the treatment and control groups in studying this section of the curriculum.

CHAPTER V

STATISTICAL ANALYSIS OF RESULTS

The data collected were analysed statistically using the Statistical Package for the Social Sciences (SPSS) on the Honeywell Multics system at the University of Calgary, and programs written for the VAX 750 in the Faculty of Education Computer Applications Unit at the University of Calgary. The attitude tests were analysed by Alberta Education in Edmonton. A probability level of .05 was used to determine significance for all data analysis in the study.

The main hypotheses were each concerned with the difference between the means of two sets of scores.

An accepted procedure for evaluating such a difference is to conduct a t-test, either correlated or uncorrelated as appropriate. This requires normality of distribution and homogenity of variance which, in educational data, are frequently not obtained. However, it has been suggested, for instance by Harnett and Murphy (1980), that the test is quite robust and may, therefore, be used even if such assumptions are not met.

On the other hand, Edgington (1980) has pointed out that it would be more appropriate to assess obtained t-values not by reference to tables, but by means of a

randomization test. This eliminates the requirement for normality of distribution and homogenity of variance, and is obviously more appropriate for data of the type under consideration. However, it also requires far more computational power and time.

It was, therefore, decided to first assess all t-values by reference to tables of t. Then, if any proved to be significant, they would be further assessed by means of a randomization test. Such a procedure was conservative, in the sense that no results would be accepted as significant for which the data did not meet the requirements of both the traditional t-test and the randomizaion test.

For both the achievement and attitude means, an uncorrelated t-test was performed on the pre-test scores of the treatment group and the control group to determine if there was a significant difference between the two groups. Correlated t-tests were performed for the control and treatment groups separately, to compare pre- and post-test scores. An uncorrelated t-test was performed on the post-test scores of the control group and the treatment group to determine if there was any significant difference in the post-test achievement level or attitudes of the two groups.

Results: Achievement Measures

The means and standard deviations of the treatment and control groups on the measure of achievement are displayed in Table 6. Menu planning and nutrient groups were treated as different concepts, thus the results were analysed separately. The data recorded for the subjects consisted of the number of correct answers out of a possible score of 28 on the menu planning test and out of a possible score of 26 on the nutrient group test.

There was no significant difference between the pre-test scores of the treatment group and the control group on the menu planning test ($t = 1.115$; $df = 22$; $p > .10$) or on the nutrient group test ($t = .905$; $df = 22$; $p > .10$) (see Table 7). Therefore, hypothesis one, that there would be no significant difference between the pre-test scores on the achievement test for the two groups, was upheld. Thus it can be concluded that the treatment and control groups started with the same level of achievement.

Both the treatment and control groups showed improvement from their pre-test scores to their post-test scores on both sections of the achievement test (see Table 6).

In menu planning there was significant improvement in the scores on the achievement test for both the treatment group ($t = -6.868$; $df = 11$; $p < .0005$) and the control

TABLE 6

SUMMARY OF SCORES FOR THE ACHIEVEMENT TESTS

	CONTROL GROUP		TREATMENT GROUP	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
MENU PLANNING				
MEAN	9.38	18.667	11.912	20.136
STANDARD DEVIATION	3.687	3.172	2.968	3.136
NUTRIENT GROUPS				
MEAN	3.333	13.25	4.75	12.917
STANDARD DEVIATION	2.103	5.93	1.357	4.581

TABLE 7

COMPARISON OF THE TREATMENT GROUP AND THE CONTROL GROUP ON THE ACHIEVEMENT PRE-TEST

	t-VALUE	DF	PROB.
MENU PLANNING	1.115	22	>.10
NUTRIENT GROUPS	.905	22	>.10

TABLE 8

COMPARISON OF PRE- AND POST-TEST SCORES ON THE ACHIEVEMENT TESTS

	t-VALUE	DF	PROB.	RAND. PROB.
MENU PLANNING				
TREATMENT GROUP	-6.868	11	<.0005	<.0005
CONTROL GROUP	-8.999	11	<.0005	<.0005
NUTRIENT GROUPS				
TREATMENT GROUP	-6.014	11	<.0005	<.0005
CONTROL GROUP	-6.480	11	<.0005	<.0005

TABLE 9

COMPARISON OF THE TREATMENT GROUP AND THE CONTROL GROUP ON THE ACHIEVEMENT POST-TEST

	t-VALUE	DF	PROB.
MENU PLANNING	-1.141	22	>.10
NUTRIENT GROUPS	-.1542	22	>.25

group ($t = -8.999$; $df = 11$; $p < .0005$). Similarly, in the nutrient section, there was significant improvement in the scores for both the treatment group ($t = -6.01$; $df = 11$; $p < .0005$) and the control group ($t = -6.48$, $df = 11$; $p < .0005$) (see Table 8). Randomization tests, systematically using all possible interchanges of scores, confirmed the significance of each of these t-values.

Hypothesis two, which stated that for each group there would be no significant difference between the pre- and post-test scores on the achievement test, is rejected based on the preceeding results. Thus it can be concluded that both the CAI and the traditional teaching methods were successful in improving the students' menu planning skills and knowledge of the five nutrient groups.

No significant difference was found between the post-test scores of the treatment group and the control group on the menu planning test ($t = -1.141$; $df = 22$; $p > .10$) or the nutrient group test ($t = .1542$; $df = 22$; $p > .25$) (see Table 9). Hypothesis three, that there would be no significant differences in the post-test scores on the achievement test for the two groups, therefore, was upheld. Thus it can be concluded there is no evidence that the CAI and the traditional method resulted in different levels of achievement.

Results: Attitude Measures

School Subjects Attitude Scales.

The semantic differential attitude questionnaire measured the students' attitude toward Home Economics. Tables 10, 11 and 12 indicate the mean, standard deviation and variance for each of the three factors measured on the attitude test.

Although a nonparametric test would seem to be indicated because the data may be regarded as consisting of nominal scores, there is an established tradition of using t-tests for significance testing on the semantic differential questionnaire results.

Uncorrelated t-tests were used to test for a significant difference between the means of the treatment and control groups for the pre-test for each of the scales measured on the semantic differential questionnaire. There was no significant difference found between the two groups on any of the three scales (see Table 13). Therefore, hypothesis four, which stated that there would be no significant difference between the pre-test scores on the attitude test, was upheld. Thus, it can be concluded that the two groups had similar attitudes towards Home Economics at the beginning of the experiment.

A correlated t-test was used to compare the means of the pre- and post-test utilizing a hypothesis that the mean difference was zero. Table 14 displays the t-values

TABLE 10

SUMMARY OF DIFFICULTY SCALE ON THE SEMANTIC DIFFERENTIAL QUESTIONNAIRE

	TREATMENT GROUP		CONTROL GROUP	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
RAW MEAN	24.58	26.42	22.92	26.17
STANDARD DEVIATION	7.04	6.23	6.02	3.21
VARIANCE	49.17	38.81	36.24	10.31

TABLE 11

SUMMARY OF EVALUATIVE SCALE ON THE SEMANTIC DIFFERENTIAL QUESTIONNAIRE

	TREATMENT GROUP		CONTROL GROUP	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
MEAN	31.08	30.25	26.67	25.83
STANDARD DEVIATION	4.12	5.28	6.54	5.05
VARIANCE	17.00	27.84	42.72	25.47

TABLE 12

SUMMARY OF USEFULNESS SCALE ON THE SEMANTIC DIFFERENTIAL QUESTIONNAIRE

	TREATMENT GROUP		CONTROL GROUP	
	PRE-TEST	POST-TEST	PRE-TEST	POST-TEST
MEAN	35.00	36.00	31.62	33.67
STANDARD DEVIATION	4.22	3.81	6.80	4.90
VARIANCE	17.82	14.55	46.24	24.05

TABLE 13

COMPARISON OF THE TREATMENT GROUP AND THE GROUP ON THE SEMANTIC DIFFERNTIAL PRE-TEST

SCALE	t-VALUE	DF	PROB.
EVALUATIVE	1.9766	22	> .05
USEFULNESS	1.4632	22	> .10
DIFFICULTY	.6208	22	> .50

TABLE 14

COMPARISON OF PRE- AND POST-TEST SCORES
ON THE SEMANTIC DIFFERENTIAL QUESTIONNAIRE

GROUP	t-VALUE	DF	PROB.	RAND. PROB.
USEFULNESS SCALE				
TREATMENT GROUP	2.823	11	<.02	.0204
CONTROL GROUP	1.034	11	>.10	
EVALUATIVE SCALE				
TREATMENT GROUP	-.7720	11	>.10	
CONTROL GROUP	-.3901	11	>.50	
DIFFICULTY SCALE				
TREATMENT GROUP	.7326	11	>.10	
CONTROL GROUP	1.8760	11	>.05	

TABLE 15

COMPARISON OF THE TREATMENT GROUP AND THE CONTROL GROUP ON THE SEMANTIC DIFFERENTIAL POST-TEST

SCALE	t-VALUE	DF	PROB.	RAND. PROB.
EVALUATIVE	2.0958	22	< .05	.0144
USEFULNESS	1.3006	22	> .10	
DIFFICULTY	.1236	2	> .50	

and the resulting probabilities obtained from the comparison of the scores. For all comparisons, with the exception of the usefulness scale for the treatment group ($t = 2.823$; $df = 11$; $p < .02$), hypothesis five could not be rejected. Hence, it was concluded that the mean difference was zero for each component of the attitude test except that the treatment group showed an increased positive evaluation of the usefulness of the subject. The significance of this t-value was confirmed by a randomization test.

Uncorrelated t-tests were used to test for a significant difference between the means of the treatment group and the control group on the post-test for the three scales measured on the attitude test (see Table 15). A significant difference was found between the two groups on the evaluative scale ($t = 2.0958$; $df = 22$; $p < .05$). Again, this was confirmed by a randomization test.

Hypothesis six, which stated that there will be no significant difference in the mean post-test scores between the two groups can only be rejected for the evaluative scale.

Computer Acceptance Test.

The second attitude test was concerned with students' attitude toward computers. The first three questions required the students to respond using a five point scale. The other two questions required the students to write

sentences to answer the questions. The students' sentences were marked using a three point scale: 'one' represented a negative response, 'two' represented a neutral response, and 'three' represented a positive response. The appropriate nonparametic test for these nominal scores is chi-square. This test compares the variance of the distribution for the treatment group scores from the computer acceptance test with an even distribution. These tests were performed and the results are shown in Table 16.

The students found it easy to use the computer (chi-square =38.84; df = 4; $p < .005$), found it made learning easier (chi-square = 18.84; df = 4; $p < .005$), and liked using the computer to assist them in learning (chi-square = 48; df = 4; $p < .005$). The results of the questionnaire indicated that the students had a positive attitude towards both the Home Economics classes (chi-square = 6.5; df = 3; $p < .05$) and the school (chi-square = 9.5; df = 3; $p < .01$).

Time

The control group required a total of 240 minutes of class time to complete the lessons. Since the students were also required to complete a menu planning assignment at home, no data are available for the total time required for the control group to complete the homework assignment.

The mean class time for the treatment group to

complete the instruction using CAI was 210 minutes. It should be noted that the students in the treatment group were required to plan a menu for seven days rather than just three. Thus, it would appear that the treatment group required less time to complete the lessons.

TABLE 16

CHI-SQUARE VALUES FOR THE COMPUTER ACCEPTANCE QUESTIONNAIRE

	QUESTION	CHI-SQUARE	DF	PROB.
1	Do you like using the computer to assist you in learning?	48.0	4	<.005
2	Does the computer make it easier to learn?	18.84	4	<.005
3	Do you think it is easy to use the computer?	38.84	4	<.005
4	Do you feel that the computer has made any difference in the way you feel about Home Economics classes?	6.5	2	<.05
5	Do you feel that the computer has made any difference in the way you feel about our school?	9.5	2	<.05

CHAPTER VI

DISCUSSION

Introduction

The main purpose of this study was to determine if CAI was an effective method for teaching Grade Nine Home Economic students: the four food groups; menu planning skills; and the five nutrient groups. Courseware to teach these skills and knowledge was developed and tested.

The CAI programs covered two nutrition areas. The first series of lessons covered the four food groups, Canada's Food Guide (DHW, 1982), and how to apply this knowledge to plan meals. The second series of programs addressed the food sources and functions of the five nutrient groups.

The main aims of the experiment were to determine first if the students receiving CAI showed changes on both the measures of attitude and achievement between pre- and post-test scores and secondly, if this change would be as great as the change shown by the students receiving traditional instuction.

A secondary question was also considered. This was to determine if the students who received CAI would finish in the same amount of time as the students who received traditional instruction.

The sample groups were drawn from two Grade Nine Home Economics classes in a rural junior/senior high school. Six students from each of the classes were randomly selected for the treatment group. From the remaining students, six were randomly selected from each class to make up the control group. The sample size and selection procedure were dictated by student population and availability of hardware. Both the treatment group and the control group consisted of three males and nine females.

During the experiment the treatment group received CAI and the control group received traditional instruction. The experiment was conducted during the month of February. At this point in the school year the students had completed the sewing portion of the curriculum. The curriculum content covered in the experiment was in the first unit in the cooking section.

Achievement Tests

The students in both the treatment and the control groups showed significant improvement from the pre-test to the post-test on the measure of achievement. However, the difference in the level of improvement between the two groups was not statistically significant. These results indicate that CAI was as effective as traditional instruction in meeting the instructional objectives of this portion of the curriculum.

Attitude Tests

The change of attitudes towards Home Economics and computers was tested. Two tests was employed. The first was developed and scored by Alberta Education. This test provided data on difficulty, usefulness and evaluative scales. The second test consisted of five questions deemed by the researcher to measure how the CAI had influenced the students' attitudes towards: the use of computers; Home Economics classes; and their school.

Attitude Towards Home Economics.

Although both the treatment and the control group evaluated the class as being more useful on the post-test than on the pre-test the increase was significant only for the treatment group.

On the evaluative scale there was no significant difference between the means for the control and the treatment groups on the pre-test. Also, there was no significant difference when comparing the means for the pre- to post-test for either the treatment or control group. Notwithstanding, there was a significant difference between the means of the post-test with the treatment group evaluating the course higher than the control group.

These changes in attitude could be related to two different factors, the first being the use of CAI, and the second being the change from sewing to cooking. The

majority of students prefer the cooking portion of the curriculum. Thus, the change in attitude may not be attributed totally to CAI.

Attitude Towards Computers.

The results of the computer acceptance questionnaire indicated that the students in the treatment group had a positive attitude towards computers. The students found it easy to use the computers, found it made learning easier, and liked using the computer to assist them in learning. The majority of students in the treatment group had no previous exposure to CAI. Thus, novelty may be a factor contributing to the attitude change. If the experiment were to be repeated using a sample which was familiar with CAI, similiar results might not be obtained.

Existence of a novelty factor was suggested during the experiment. By the end of the second lesson, for example, the students were inquiring when they would be allowed to start preparing food.

Secondary Hypothesis

The secondary hypothesis was that the students in the treatment group would require as much time to complete the CAI programs as the students in the control group. Because the control group completed an assignment at home and planned menus for three days, rather than seven, statistical tests could not be performed.

The control group required a mean of 240 minutes of

class time, whereas the mean class time for the treatment group was 210 minutes. Thus, it would appear that the treatment group required less time to complete the lessons. They also received more practice in using the skills covered in the instruction as they planned menus for seven days, whereas the control group only planned for three days.

Problems Encountered

In this experiment the main problems were related to the availability of computers and the limited storage capacity of the disks.

Only four machines were available for the experiment. Two of these were on the main floor of the school while the other two were in the basement. The problem was further complicated by the fact that the instructor was also teaching the control group at the same time. In future studies: all the computers should be in one area; and there should be either two instructors available, one for each group, or the control and treatment groups should be taught at two different time periods.

The second problem involved mechanical difficulties. One of the disk drives malfunctioned and destroyed one of the disks. Thus, a new CAI disk had to be created before the student could continue. Therefore, it is recommended that back-up copies of each disk should be made after each session at the computer.

General Observations and Comments

The students in the treatment group enjoyed working at the computers. Due to the lack of available hardware, not all the students were able to complete the CAI lessons during regular class time. This was not a serious problem because the students were willing to come in at noon hour and after school to finish the lessons.

The students in the control group were very curious about the CAI lessons. After the experiment some of the students from this group used the CAI lessons.

A common complaint about the CAI lessons was that they were too 'picky'. For example, the computer required correct spelling for all responses.

Suggestions For Further Research

Further reseach could be done to determine what type of required input by the student is most effective. It would be interesting to determine if entering either words or entire sentences would be more effective than entering a single character, as is done for multiple choice and true or false questions.

A further point of interest would be to determine if CAI programs in this subject area can improve long term retention of learning.

Another point for consideration would be to determine the importance of the 'novelty' factor when students use CAI. It would be interesting to repeat the experiment

comparing the results of a group of students who are already familiar with CAI with another group of students who have no familiarity with CAI.

Another area that could be explored is the effect of CAI on the students' actual eating habits. It is one thing to know what a correct diet is, but it is another thing to actually follow a correct diet.

Limitations of the Experiment

It is not possible to say whether the CAI programs would have been as effective if they had been compared to individualized tutorials in other Grade Nine Home Economics classes in the community.

Since the sample consisted of students drawn randomly from two Home Economics classes at one institution who were not familiar with CAI, the findings can not be generalized beyond this point.

No attempt should be made to generalize the results obtained from a limited exposure to CAI to conclude that similar results would be obtained for a longer exposure to this form of instruction.

Conclusions

Within the limitations of the study it was shown that both students receiving CAI and traditional instruction increased their level of mastery of the content of the subject. The mastery level of the students receiving the CAI was at least as high as that of the students receiving

traditional instruction. Further, the students receiving CAI required less time to reach this level of mastery and had a positive attitude towards Home Economics classes, school, and computers.

The positive attitudes exhibited by the subjects in the treatment group suggest that CAI may be one of the new imaginative approaches to be employed by nutrition educators to develop effective programs.

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APPENDIX

ACHIEVEMENT PRE- AND POST-TEST

1. List the four food groups found in Canada's Food Guide and their daily serving requirement.

2. Examine each of the following menus and determine if they meet the requirements of Canada's Food Guide . If it doesn't meet the requirements explain why.

a) Breakfast
fried eggs
orange juice

Lunch
cheese sandwich
apple

Supper
roast pork
potatoes
corn
roll
milk
chocolate pudding

Snack
milk
cookies

Does this menu meet the requirements of Canada's Food Guide ? If not explain why?

b) Breakfast
pancakes
hot chocolate
apple juice

Lunch
luncheon meat
cottage cheese
hard-boiled egg
bun

Supper
fried chicken
mashed potatoes
peas
milk
ice cream

Snack
chocolate cake

Does this menu meet the requirements of Canada's Food Guide ? If not explain why?

c) Breakfast
toast
milk

Lunch
hamburger
french fries
coke

Supper
lasagne
milk

Snack
apple

Does this menu meet the requirements of Canada's Food Guide ? If not explain why?

d) Breakfast
eggs
sandwich
toast
orange juice

Lunch
grilled cheese

milk

Supper
salad
T-bone steak
cottage cheese
milk

Snack
apple
milk

Does this menu meet the requirements of Canada's Food Guide ? If not explain why?

3. Plan a menu for yourself that meets the requirements of Canada's Food Guide .

4. List the function of each of the following:
   a) sugar

   b) starch

   c) cellulose

   d) fats

   e) proteins

5. List the 6 vitamins discussed in class and 1 food product they can be found in.

6. List the 4 minerals discussed in class and 1 food product they can be found in.

SEMANTIC DIFFERENTIAL QUESTIONNAIRE

Place only one mark between each pair of words.
Complete ALL of the pairs.

	very much	a bit	neither	a bit	very much	
nice	( )	( )	( )	( )	( )	awful
boring	( )	( )	( )	( )	( )	interesting
unpleasant	( )	( )	( )	( )	( )	pleasant
dislike	( )	( )	( )	( )	( )	like
bright	( )	( )	( )	( )	( )	dull
dead	( )	( )	( )	( )	( )	alive
lively	( )	( )	( )	( )	( )	listless (inactive, lazy)
exciting	( )	( )	( )	( )	( )	tiresome (makes a person feel tired)
useless	( )	( )	( )	( )	( )	useful
important	( )	( )	( )	( )	( )	unimportant
impractical	( )	( )	( )	( )	( )	practical (useful or workable)
worthless	( )	( )	( )	( )	( )	valuable
helpful	( )	( )	( )	( )	( )	unhelpful
unnecessary	( )	( )	( )	( )	( )	necessary
harmful	( )	( )	( )	( )	( )	advantageous (brings good or gain)
meaningful	( )	( )	( )	( )	( )	meaningless
hard	( )	( )	( )	( )	( )	easy
light	( )	( )	( )	( )	( )	heavy (a lot of work)
clear	( )	( )	( )	( )	( )	confusing (mixes a person up)
complicated	( )	( )	( )	( )	( )	simple
elementary	( )	( )	( )	( )	( )	advanced (beyond the beginning level)
strange	( )	( )	( )	( )	( )	familiar
understandable	( )	( )	( )	( )	( )	puzzling (hard to understand)
undemanding	( )	( )	( )	( )	( )	rigorous (has to be exactly

right)

COMPUTER ACCEPTANCE QUESTIONNAIRE

1. Do you like using the computer to assist you in learning? yes ( ) ( ) ( ) ( ) ( ) no

2. Does the computer make it easier to learn? yes ( ) ( ) ( ) ( ) ( ) no

3. Do you think it is easy to use the computer? yes ( ) ( ) ( ) ( ) ( ) no

4. Do you feel that the computer has made any difference in the way you feel about Home Economic classes?

5. Do you feel that the computer has made any difference in the way you feel about our school?