AN ABSTRACT OF THE THESIS OF

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Title: Food Item Inventory Instructional Simulation Using Microcomputers

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The purpose of the research project was to teach the management of perpetual and periodic inventory systems to university students in the field of food systems management through the use of a microcomputer software program developed for this purpose. The objective of the study was to determine the classroom simulation's effectiveness in enhancing students' understanding of inventory systems management.

The population sample consisted of 68 students enrolled in a senior level food systems management course at Oregon State University. Simple random sampling was used to divide the population sample into two groups: an experimental group and a control group. All the participants completed a pretest to measure existing knowledge of inventory management concepts. This was followed by two fifty-minute classroom educational modules on the management of perpetual and periodic inventory systems in foodservice facilities. The members of the experimental group participated in using the microcomputer simulation program of food item inventory systems after the classroom

modules. All the participants of the experimental and control groups completed a posttest approximately three weeks after the pretest. The difference in pretest mean scores between the experimental and control groups was not significant ($P \leq .05$) as determined by the student's t-test. This indicated the two groups were similar to each other in previous knowledge of inventory management. The difference in posttest adjusted mean scores between the experimental and control groups was significant ($P \leq .05$) as determined by analysis of covariance. Therefore, the microcomputer simulation was effective in enhancing students' understanding of the management of the perpetual and periodic inventory systems.

Food Item Inventory Instructional Simulation Using Microcomputers

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Food Item Inventory Instructional Simulation Using Microcomputers

INTRODUCTION

Research in computer-assisted foodservice management systems has been conducted for the past twenty-five years. Frequently, only large universities and teaching hospitals with expensive mainframe computers in place had the opportunity to utilize this powerful management tool in either education or operations management (1, 2, 3). For example, the University of Missouri-Columbia Medical Center was one of the first to develop an integrated computer-assisted food systems management program in the early sixties (1). Other large institutions later followed suit. During recent years the proliferation of less expensive microcomptuers has made it possible for the majority of foodservice managers to realize the benefits of computer technology. By storing records and generating routine reports, microcomputers have the means to provide managers with objective, current data regarding operational status to make complex decisions and to improve operational efficiency (4). Managers no longer need to rely solely on intuition, judgment, and experience in decision making and problem solving (1).

The use of computers has been recognized as an important component in an undergraduate curriculum in university foodservice management programs as well as in operations. Though there were educational software and simulation programs in dietetics for the mainframe computer, only a few programs met the need in teaching students in food systems management. An instructional simulation model, "Dietetic Com-Pak," was developed and tested in 1972 for the mainframe computer by Hoover and Moore (2, 5) to provide simulated learning experiences in computer-assisted food systems management based on the existing system at the University of Missouri-Columbia. Many of the educators that participated in testing "Dietetic Com-Pak" incorporated the simulation model into the curricula of their respective educational institutions. These same educators at the Eighth Conference of the Foodservice Systems Management Education Council, in Denver in 1975, recommended the use of computer assistance in making management decisions as a required competency for the entry level dietitian (6).

Other mainframe simulation programs were developed for educational purposes in food systems management. A computer-assisted individualized instruction unit on inventory management was utilized in research done by West (7) in 1976 at the University of Knoxville. Results of the study indicated that the use of the computer simulation in an individualized study unit did produce results equivalent to the traditional lecture method. Computer-assisted case studies to teach personnel management competencies to students in the Coordinated Undergraduate Program at the University of Tennessee-Knoxville were developed by Canter in 1977 (8). Though the effectiveness of the personnel case studies simulation was not evident in the results of objective measurements used, students and faculty involved responded positively to the experience and showed interest in continuation and expansion of the computer-assisted instructional method.

With the increasing utilization of microcomputers in the food-service industry, more opportunities must be provided in the educational setting for students in food systems management to gain the necessary competencies to function in a microcomputer-assisted food-service operation. These opportunities should be designed to provide the students with the knowledge and skills to apply and teach others in the food systems management industry throughout their professional careers. One way this educational competency may be provided is to develop educational simulation and microcomputer software programs in the many interrelated areas of a food systems operation. The food item inventory is one of the foodservice subsystems that could be simulated by a microcomputer software program. Simulation of a food item inventory would provide the participants with an opportunity to experience many typical operational situations which would otherwise be impractical or impossible due to economic or time constraints of the classroom. In addition, the participants would be more likely due to the experience of interacting with the simulation program in the academic curriculum to transfer inventory management skills learned from the training situation to operational situations.

The opportunity to learn and apply inventory management techniques through microcomputer simulation has not been readily available due to the scarcity of appropriate software programs. Only within the last two years have any microcomputer programs been developed to meet the educational needs in food systems management. An inventory software program was created by Adams (9) in 1984 at Oregon State University to provide continuing education experience in computer-assisted management to foodservice practitioners in schools and hospitals. The program has also been adopted for use by food systems management departments of several colleges. Cookware (10), an operations application software program from Computran Systems, Inc., of Beaverton, Oregon, is a microcomputer program based on the "Dietetic Com-Pak" mainframe computer program. The program contains four interrelated functional modules: a master cycle menu planner, nutritional analysis, inventory control, and food production control. This applications program has been incorporated into the Computer-Assisted Foodservice Management elective course at Oregon State University.

The purpose of this study was to teach management of perpetual and periodic inventory systems to university students in the field of food systems management through the use of a microcomputer software program developed for this purpose. The objective of this study was to determine the classroom simulation's effectiveness in enhancing students' understanding of inventory systems management. The null hypothesis of this study was: there will be no significant difference ($P \leq .05$) in knowledge gained in inventory systems management through the use of microcomputer simulation between the persons who participate in the computer simulation exercise and the persons who do not.

REVIEW OF LITERATURE

Foodservice Inventory Management

The foodservice industry is complex. This complexity is due to the variety of functional areas that must be integrated by the foodservice manager to achieve an effective, efficient, foodservice operation (1). Some of these functional areas include inventory, production, purchasing, marketing, cost accounting, and labor. Each of these functional areas may be further subdivided into smaller areas. For example, the inventory area includes perishable foods, staple goods, paper products, cleaning supplies, buffer stock, and seasonal items. These inventories represent a substantial investment for the foodservice operation for which the foodservice manager is held accountable. Thus, the manager must learn to balance the amount of inventory needed to carry a variety of items and still minimize the cost.

Generally, an inventory can be any resource that has value because it can satisfy a future need (14). Adam and Ebert (11) define inventory as the store of goods and stock. Axler (12) describes inventory as products stored to meet future requirements while Gallagher and Watson (13) state that inventories function as a buffer between supply and demand.

Inventory Classification

Inventories may be classified in several ways, depending upon the criterion established for the foodservice operation (11, 12).

Physical inventories may be classified according to the stage of completion in the production process. In the case of foodservice operations there would be three categories: raw goods, work-in-process, and finished products.

The term raw goods is too narrow a description of food items in a foodservice operation's inventory as foods may be purchased in any of the following three forms: (1) basic ingredients such as flour, eggs, lettuce, and dried beans; (2) ready-to-prepare items like cake mixes, canned vegetables, and frozen fruit juice concentrate; and (3) ready-to-serve items such as sliced bread, canned fruit, and milk. The raw goods category includes basic ingredients, ready-to-prepare items, and ready-to-serve foods which are used to make foods in the work-in-process inventory such as cake batter. In most foodservice operations the work-in-process inventory is usually a temporary one that is not formally accounted for in any record keeping system but is accounted for in the finished products inventory. The finished products inventory are the completed menu items like a frosted layer cake or beef stew.

Another method by which foodservice inventories may be classified is according to annual dollar usage which is also known as ABC analysis or Pareto analysis (15). ABC analysis states that items in a foodservice inventory may be split into three groups based on the number of items used annually multiplied by the purchase price or dollar value per item. Class A items may represent only 15 percent of the inventory items but account for 45 percent of the total dollar value of the inventory. Therefore, the number of items in this classification should be kept to a minimum and under constant review. Class B items may represent 30 percent of the volume on hand but accounts for only 35 percent of the total dollar value. The moderate volume and dollar value may require only quarterly or semi-annual review of the items in this category. The class C items may represent 55 percent of the inventory items but only 20 percent of the total dollar value. The items in this category may require only annual review.

Justification of Inventory

The main reason a foodservice operation carries an inventory is the physical and economic necessity of having the right amount of raw goods and supplies available exactly when and where they are needed. Even if it were physically possible to have vendors deliver supplies every few hours to the foodservice production area, it would still be prohibitively expensive (11). Maintenance of an adequate inventory then becomes necessary to assure an uninterrupted supply of raw goods and supplies at a minimum cost for the preparation of menu items as demanded by consumers (16).

Carrying an adequate inventory results in additional advantages. These advantages include: (1) foodservice managers will be able, whenever possible, to purchase food and supplies in bulk at a quantity discount cost and therefore keep inventory investments at a minimum point (11, 14, 17); (2) inventories also make it possible to have smooth production levels and minimize labor and operational costs;

and (3) an adequate inventory provides a buffer against production schedule interruptions due to shortages of materials even though supply may be irregular due to economic and seasonal factors (11, 14, 17).

Inventory Costs

Food inventories represent a large initial investment and ongoing costs for the foodservice operation. All costs associated with the inventory must be identified and controlled. Four categories of costs have been identified which include: (1) the cost of the item, (2) procurement, (3) carrying, and (4) stockout costs (11, 13, 14). The cost of the item is usually equal to the purchase price. In some cases additional costs may be included in the purchase price for taxes, transportation, receiving, and inspection. Procurement costs are those incurred by placing a purchase order which may include personnel salaries, telephone calls, postage, and purchase order supplies, and set-up costs. Set-up costs include all the costs necessary to set up the production process to produce menu items (14). Carrying costs consist of utility costs, taxes or rent on storage space, insurance; losses due to pilferage, spoilage, or breakage; labor, maintenance of inventory records; and interest on the money invested in the inventory. Stockout costs occur when inventories have been depleted resulting in backorder costs as well as a loss of actual sales and consumer goodwill (11, 13, 14, 18).

Fixed Order System

The foodservice manager must make two interrelated decisions when planning and controlling inventory: when to order and how much to order (11, 12, 17). Two systems, the fixed order system and the fixed period system, have been developed to aid the foodservice manager in making these decisions. The fixed order system, also known as the perpetual system, may be used where the time period between orders varies with fluctuations in demand while the quantity ordered each time period remains constant. In this system it is necessary to keep a perpetual record of the current balance of inventory on hand. When the amount of inventory on hand falls to a predetermined level, a fixed quantity is ordered. The quantity ordered is usually enough to meet expected demand during the lead time. Lead time is the time between ordering and receiving (13, 14).

Fixed Period System

The second inventory system is the fixed period where the order size varies with fluctuations in demand while the time period between orders remains constant. This system is also known as the periodic system because the inventory is reviewed at regular fixed periods and an order is placed to bring the balance of inventory on hand up to a desired level. The quantity ordered is usually enough to meet expected demand during the lead times plus buffer stock to cover one reorder period. Buffer stocks represent an "inventory within an inventory" (12) which are used to protect against uncertain product demand and uncertain lead times.

Advantages of Inventory System Models

The inventory system that is selected by the foodservice manager will depend on the size of the foodservice operation and the advantages offered by each of the two systems. The fixed order system will require less buffer stock to protect against uncertainties of demand and lead time than the fixed period system. This reduced buffer stock is possible because the frequency of orders is dependent upon demand. If an unusually large demand occurs, a new order can be placed immediately to avoid the possibility of a stockout. In the fixed period system costs tend to be greater than in the fixed order system. This is due to the greater possibility of a stockout occurring during a time of unusually high demand and the probability of carrying an excessive amount of buffer stock to avoid the possibility of stockouts (11).

The fixed period system requires less personnel to maintain the inventory than the fixed order. It is not necessary to have personnel count each item as it is issued or received as is required in the fixed order system. A physical inventory is only taken at the end of each predetermined period. This system is generally used in smaller foodservice operations which have a minimum of personnel. The calculation of net inventory takes less time in the fixed period system and therefore the costs tend to be lower than in the fixed order system (11).

Computers in Foodservice

The foodservice manager's efforts to achieve an effective, efficient operation can be aided by the use of computer technology. Automation of routine and repetitive record keeping, results in two major benefits for the foodservice manager: (1) objective information regarding the status of the various interrelated functional areas and (2) time to utilize the information provided to make complex decisions and improve operational efficiency (4, 19).

The foundation of successful application of computer technology in the foodservice industry is the careful compilation of a data base system. A data base is a body of information stored in one or more files in a computer's secondary memory for access by a group of programs over a period of time (4). The University of Missouri-Columbia Medical Center's Master Data Files were used by Balintfy (20) at Tulane University during the development of a program titled, Computer-Assisted Menu Planning (CAMP). This data base included food item, recipe, and nutrient files. The food item file contained such information as a description of the food item, the buy unit, minimum and maximum stock levels, and cost per unit. The recipe file included the recipe name, number of ingredients, minimum and maximum batch size, and selling price. The nutrient file contained a compilation of nutrient data acquired from USDA Handbook No. 8, periodical literature, and food manufacturers. These files formed the data base necessary to make computerized menu planning and other computerized foodservice management tasks operational. Youngwirth (21) stated that computer technology has been successfully applied in the foodservice industry in the areas of dietetics, education, and management.

Dietetics

Computer applications in hospital dietetics have included nutrient analysis, communication, and patient interviews. Computerized nutrient analysis has been used, for example, to check the nutritional adequacy of sample menus in a diet manual (22), patient food consumption records (23), and diets of selected populations in epidemiologic studies (24). Computerized nutrient analysis has been proven to be more cost effective and accurate than manual calculation (25). Consequently, computerized nutrient analysis has become a standard procedure in many facilities and has aided in individualizing patient care (19). Timely communication of patient information to foodservice as well as other departments in a health care facility is considered essential for high quality care. Sending messages regarding admissions, discharges, room transfers, diet orders, and laboratory tests via computer to foodservice assures the correct meal tray is ready for delivery to the patient at the appropriate time and place (26). Some computer systems also permit hospital dietitians to enter notes into individual patient records stored in the comptuer's memory through a cathode ray tube terminal (27). Use of programmed computer terminals to interview patients regarding food preferences and habits has been documented (28, 29, 30). Professional time was saved, the patients appreciated the automated interview, and more complete, accurate information could be obtained to update the foodservice inventory in order to meet patients' needs more readily.

Foodservice Education

Computers have been utilized as an instructional tool in the foodservice industry by hospital employees and by college students with majors in foods, nutrition, and hotel/restaurant management. Computer-assisted instruction has been successfully used to teach sanitation to hospital foodservice employees (31). College students have been able to learn menu planning (32), nutrition (33), foodservice personnel management (8), and financial management (34) through the use of computer programs. Computer simulations ranging from clinical encounters with hospital patients to foods laboratory experiences have also been found to be effective in teaching college foodservice students (35, 36).

Foodservice Management

The greatest benefits of computer technology have been realized by those institutions which have integrated the various functional areas into a total computer-assisted food management system. Computer technology has been applied to the following areas in foodservice management: menu planning, forecasting, production, inventory management, and food cost accounting.

Menu Planning

Initial research into the development of computer-assisted foodservice management systems was begun by Dr. Joseph Balintfy in 1962 at Tulane University (20). Under his direction, a program titled Computer-Assisted Menu Planning (CAMP) was designed. Based on a mathematical model, the linear program was able to plan non-selective menus for a sequence of days that met the requirements of at least cost, palatability, and nutritional adequacy. As CAMP and other menu-planning programs were further developed and refined it became possible to plan selective menus and modified diet menus (37, 38). Utilizing CAMP, managers can better meet nutrient requirements, improve accuracy, reduce raw food costs, save dietitians' time, and increase consumer satisfaction (37, 38).

Forecasting

Computerized forecasting techniques are an area of foodservice management that can aid in more efficient control of other food-service functions such as inventory and production. Forecasting may be defined as the use of past historical data to generate projections of the future (13). Research into computer-assisted forecasting at the University of Missouri-Columbia by Messersmith et al. (39) involved the use of three interdependent echelons to generate a statistical forecast of menu item demand for hospital patient meal service. Results showed that the computer-assisted menu item fore-cast error costs were approximately 40 percent less than the cost of the manual forecasting system. Later, at the same institution, researchers found that a two-echelon system was less complicated and resulted in an even lower forecast error costs than the three-echelon system (40). The practical application of computerized menu item demand forecasting to foodservice management can result in lower inventory carrying costs by maintaining only the necessary quantities in stock. Menu item demand forecasting can lower food and labor costs by preventing either over- or underproduction of menu items as well as fewer stockouts which results in greater customer satisfaction.

Production

Adjusting recipies and preparing food production records to meet daily consumer demand are tedious, repetitive tasks that are ideally suited to computerization. The computer program model developed by Sager and Ostenso at the University of Wisconsin (41) was able to adjust recipes to meet hospital patient census needs. The program also provided a summarized requisition of ingredients to be purchased or ordered from storeroom inventory. Similar computerized food production programs at the University of Missouri-Columbia Medical Center, included further refinements (42). In addition to the adjusted recipes and storeroom inventory requisition, an advance preparation list and an advance withdrawal from freezer report were printed. These additional reports allowed items to be defrosted and/or measured in an ingredient room according to each adjusted recipe prior to delivery to the appropriate foodservice production area. The benefits of implementing a comptuer-assisted food production system in conjunction with an ingredient room are fewer clerical hours required to adjust recipes and prepare ingredient requisitions, better utilization of cooks' time, more consistent food quality, less food waste, and lower food costs (41, 43). The University Hospital of Cleveland realized a cumulative total savings in food costs of $700,000 from 1971 through 1975 after developing a computerized food production system (44).

Inventory

The University of Missouri-Columbia Medical Center which assisted in testing the CAMP program, continued to develop their own computer applications in foodservice management. The first component to be designed and implemented was the inventory control system in 1966 (45). The main purpose of this system was to automate requisitioning of food and supplies from a central purchasing department in order to provide an adequate quantity for production while minimizing the amount of stock on hand (46). Daily transactions of purchases and issues were the inputs to the computer. Each input had to include the type of transaction, a five-digit identification code number for food items, quantity of stock units, the foodservice requisitioning area, and code number of the person recording each transaction.

The inventory contorl system outputs were the reports resulting from processing the daily transactions. These reports included an error and status log, perpetual inventory and recommended purchases, daily report of purchases and issues, as well as daily and monthly summaries of purchases and issues (2). If no issues were processed for an item during the preceding month, the date of the last issue was listed to notify the foodservice manager that the food item should be used before its shelf life expired.

In order to maintain an accurate perpetual inventory, it remains necessary to take periodic physical inventories to reconcile discrepancies which may occur due to clerical errors or lax requisitioning procedures (17, 19). When the perpetual inventory has been reconciled with the physical inventory, a report is generated to show the discrepancies as an overage or shortage in dollar values by food item and by food item categories. Further refinements of the inventory system in 1978 by Wilcox et al. (47) at the University of Missouri-Columbia resulted in an automated purchasing system for meat and frozen foods based on menu item forecast, safety stock levels, and accumulated orders already placed to vendors. This improvement to the 1966 system optimized the inventory levels of these food items while minimizing stock outages.

Later, the University of Kansas Medical Center reported the implementation of a computerized inventory system which, in addition to the usual raw foods inventory, maintained a separate inventory for prepared foods in a cook/freeze food production system (48). When any prepared food item fell to a preset minimum inventory level, the computer generated production reports including adjusted recipes, lists of ingredients to be issued, and a list of recommended purchases. In addition, the computer program maintained labor cost records for the prepared foods inventory. This cost information allowed the foodservice manager to appropriately price, monitor, and adjust production costs of any menu item.

An inventory/purchasing system at the Community Hospital of Indianapolis, Indiana (49), was able to calculate the amount of each item needed to fulfill the menus, select the vendor based on the lowest price bid on each food item, and print the purchase orders. The computer could also check the delivery invoice against the original purchase order. Discrepancies in either price or quantity could be immediately detected. Recipe and menu costs could also be updated when the purchases were received into the computer's inventory records.

Food Cost Accounting

Current and accurate records of food costs become possible when computer-assisted inventory and production systems are already implemented. A computerized food cost accounting system was designed at the University of Missouri-Columbia (50) as a further enhancement of the existing computer system. The inventory output reports provided purchase cost data for issues to the main production unit (51). This information was utilized as input in calculating the cost of recipes based on labor time and expected yield for menu items prepared in the main production unit and delivered to satellite units within the university medical complex (52). Summary reports of total food cost and income for each satellite area could be generated daily while recipe cost reports could be updated and generated monthly

(23, 53). This cost information allowed dietitians to locate deviations from expected costs, adjust selling prices in the cafeteria, determine patient charges, and prepare budgets. Refinements of the food cost accounting system were developed by Fromm et al. (54) to further segregate costs during weekends and holidays, for specialized units within the various satellite areas, and to provide monthly summary cost information for the hospital administrative services report.

Simulations

There are many definitions of simulation found in the literature including the following: Beck and Monroe (55) state that computer simulation is a procedure in which a mathematical model of a real situation is developed for the purpose of testing or teaching; Loomba (14) defines a simulation model as a computer-assisted experimentation on a mathematical structure of a real life system in order to describe and evaluate the system's behavior through real time under a variety of assumptions; Cook and Russell (56) describe computer simulation as a numerical technique that involves modeling a stochastic system on a computer over a significant period of time.

Use of Simulations

A simulation is generally used in any of three ways: (1) to evaluate or analyze an existing system, (2) to develop and evaluate a model or plan for a new system, and (3) to provide a learning environment that represents a real life situation (55). All these applications contain two variables, decision variables and criterion variables. In each of these applications the model of the situation is experimented upon for a predetermined time period. This is done by putting into the model specific values for the decision variables, under assumed conditions, and observing their effect on the criterion variable at the end of the time period. For example, it is possible to test the effect of different decision variables such as order quantities and reorder points on an inventory for a one year time period. This is done under the assumed conditions of customer demand and delivery lead time on a criterion variable, which is the total carrying cost of an inventory (13, 14). At the end of the time period, the decision variables are evaluated in relation to the original problem under study. As a result of the evaluation, these decision variables could be changed. Then the entire process may be repeated until a satisfactory solution is obtained (18).

Characteristics of Instructional Simulations

Beck and Monore (55) identify four major characteristics of simulations as an educational tool. First, simulations provide a learning environment analogous to a real life situation. Second, simulations permit low-risk input by the participant with irrevocable commitment or changing the original situation. Third, simulations provide immediate symbolic feedback of the consequences of the participant's decisions. Fourth, the entire simulation exercise is replicable allowing the participants to try various procedures in arriving at a best solution.

Advantages of Instructional Simulations

Instructional simulations can provide the participants with the opportunity to experience a real life situation that would otherwise be impractical or impossible due to safety, economic, or time constraints (4, 55, 56). Simulations can replicate analogous real life situations that are too complex or expensive to be adequately represented by conventional mathematical models (14, 56). The participants will be more likely to transfer cognitive skills from the training situation to the real life situation because of direct interaction in the simulated exercise rather than just observing either an actual or simulated situation (55, 56). The characteristics of immediate feedback and replicability aid in the transfer process.

Disadvantages of Instructional Simulations

The disadvantages of simulations for teaching purposes center around difficulty in design and expense (55). The design difficulties involve achieving an accurate reproduction of the real life situation and validating the simulation program as an effective learning tool. Expenses include the cost of program development, testing, and revision; installation requirements and use of the program after development; and training personnel to effectively supervise the program's use.

Computer Simulations in Food Systems Management

The literature reveals that computer simulations have been effectively applied in several fields including dietetics and foodservice management. Use of simulation as a technique to study foodservice system behavior was tested in 1963 by Knickrehm et al. (57). Two programs were written for a mainframe computer to simulate a cafeteria service line which could use both empirical and theoretical data. Utilizing these programs, proposed changes in either operating procedures or facility layout could be studied for their effect in reducing the time customers spent in a cafeteria service line. It was found that an infinite number of arrangements could be simulated by changing such variables as customer arrival rate, menu pattern, counter length, and number of service personnel at each station. Results of this experiment indicated that customer average total waiting time was the lowest when either customer arrival rate was controlled or the number of cashier stations were increased from one to two.

In 1965 Ostenso et al. (58) developed a general purpose cafeteria simulation program as an experimental tool to determine the optimum combination of customers, service times, service positions, and operational rules in a cafeteria facility. The initial data for defining, developing, and validating the program were obtained by observing an actual operation of a cafeteria. Then the researchers experimented with the program to determine the effect on the total cafeteria facility. Output from the simulation program provided such information as the total number of customers completing service, average waiting time before service, and average waiting and servicing time within the cafeteria service area. As a result, the simulation program was proven to be an effective, economical method to test proposed solutions to problems in existing cafeterias or designs for future cafeterias.

Beach and Ostenso (59) designed a computer simulation model showing the relationship of entree service times to the number of customers served within a given time period. Two procedures, methods-time measurement and a stop-watch time study, were used to establish normal service times for various entrees in a cafeteria service line. When the observed standard serving times data were put into the computer simulation model, it demonstrated that as entree service time increased the number of customers served decreased. Thus, in addition to evaluating present serving methods, the simulation could be used as a management tool in planning menus utilizing the optimum combination of entree items, required serving times, and number of service personnel needed to handle a given number of customers in a cafeteria service line during a specified time period.

Knickrehm (60) again used computer simulation in 1966 to experiment with seating arrangements in a cafeteria. The simulation represented customers arriving in groups, being served, selecting tables, dining, and leaving. The data for the simulation were obtained by both observing and interviewing actual customers in a cafeteria. The researchers were able to experiment with changing such variables as seating arrangement and total seating capacity. As a result, dining room space could be better utilized and customer satisfaction increased.

At the University of Wisconsin-Madison, Matthews and David (16) conducted research to determine the number of entree selections that could be economically offered on a hospital menu using prepared frozen entrees. A computer simulation was developed to study how an increase in the number of entrees served would effect storage space requirements, cost of food used, ordering and carrying costs, total cost of food and inventory, and financial investment in food inventory. The simulation models developed represented the two basic inventory systems, the fixed order period and fixed order quantity. Each of the two models were tested with both a variable and a constant meal census demand. The results demonstrated that increasing the number of entree selections did not incresae financial costs. However, the fixed order quantity models showed a greater variability in stock levels than the fixed order period model and had a wider range of storage space requirements.

The Matthew and David simulation was adapted in 1972 into a computer simulation teaching model. This model was utilized by West (7) in research done at the University of Tennessee-Knoxville in 1976. The study compared the effectiveness of an individualized instruction unit with computer simulation as opposed to the traditional lecture method in cognitive learning and application of inventory management principles. Fifty-two junior and senior level food systems administration students were randomly placed in either the experimental (individual study unit) group or the traditional lecture method (control) group. Pretests and posttests were given to all the participants as well as a retention test that was given five weeks after the posttest. Results of the study indicated that use of the computer simulation in an individualized study unit did produce learning results equivalent to the traditional lecture method. The students' prior knowledge of inventory, principles, attitude toward the teaching method, and time spent in the learning process did not effect cognitive learning or retention of knowledge.

An instructional model, "Dietetic Com-Pak," was developed in 1974 by Hoover and Moore (5) to provide simulated learning experiences in computer-assisted food systems management. The model, based on the existing computer-assisted food management system at the University of Missouri-Columbia Medical Center, was divided into four units, each representing a specific subsystem within the total foodservice operation. These four subsystems included inventory control, production control, food cost accounting, and patient nutrient intake analysis. Use and evaluation of the simulation package by 17 dietetic interns in a pilot study and later by 35 faculty members in a two-week workshop indicated significant gains in both the cognitive and affective domains. Consequently, "Dietetic Com-Pak" has been adopted by many educational institutions in order to provide dietetic students the opportunity to acquire competency in computer-assisted food systems management.

METHODOLOGY

The purpose of this study was to teach management of perpetual and periodic inventory systems to university students in the field of food systems management through the use of a microcomputer software program developed for this purpose. The objective of this study was to determine the classroom simulation's effectiveness in enhancing understanding of inventory systems management. For the purpose of this study inventory was defined as the store of food and related supplies to meet the future needs of a foodservice operation. The null hypothesis of this study was: there will be no significant difference ($P \leq .05$) in knowledge gained in inventory management techniques through microcomputer simulation between the persons who participate in the computer simulation exercise and the persons who do not. The components of the research study included the following: (1) selection of the population sample, (2) classroom education materials, (3) simulation program documentation, (4) microcomputer simulation program, (5) pretests and posttests, (6) collection of demographic data and program evaluation, (7) statistical evaluation, and (8) pilot studies.

Population Sample

The population sample consisted of 68 university students enrolled in a Foodservice Procurement and Inventory Systems course at Oregon State University. The university students were senior and graduate level students with majors in food systems management/

dietetics, foods and nutrition, health care administration, and hotel/restaurant/tourism management. It was expected that the individuals in this sample would have had a minimum level of professional work experience in foodservice management.

A sample random sampling procedure as described by Sax (61) was used to divide the population sample into two groups: an experimental group and a control group. Each participant was assigned a number. A random number table (61) was entered at a randomly selected spot and numbers were read in a predetermined direction until enough numbers had been selected to meet the desired sample size.

Classroom Educational Modules

Two fifty-mintue classroom educational modules on inventory management were presented to all the participants in this research study. The module contents were theory and processes of the following units: (1) definition of terminology related to inventory management, (2) classification of inventories, (3) identification of inventory costs, (4) explanation of the fixed order inventory system, and (5) explanation of the fixed period inventory system. At the completion of the lecture/discussion periods all the participants in the study were able to demonstrate accomplishment of the following objectives through completion of a posttest:

(1) define the terminology related to inventory management

(2) classify food item inventories according to category, stage of completion in the production process, and annual dollar volume

(3) justify maintaining an adequate inventory

(4) identify four categories of costs associated with inventories

(5) recognize marketing/operations management factors that affect inventory management

(6) define and explain the fixed order inventory system

(7) define and explain the fixed period inventory system

(8) list the advantages and disadvantages of the fixed order and fixed period inventory systems

(9) determine when and how much of an item to order in the fixed order and fixed period inventory systems

(10) establish and evaluate the minimum and maximum stock levels in the fixed order and fixed period inventory systems

(11) plan strategies to avoid stockouts of inventory items

(12) document what records must be maintained and how frequently these records must be updated

(13) document the relationship between buffer stocks and carrying costs

(14) document the relationship between procurement costs and carrying costs

(15) document the relationship between demand, lead time, and reorder point

(16) evaluate the appropriate application of the fixed order and fixed period inventory systems

Microcomputer Specifications and Simulation Operations Manual

A microcomputer and operations manual were the major tools used in implementing the software inventory simulation program. The microcomputer used in this study was an Apple brand model IIe. This model has a 64K memory, a monochrome monitor, one disk drive, and a printer. A written manual of instructions was prepared to support operation of the microcomputer and simulation program (Appendix A, page 72). The operations manual specified the type and amount of hardware required to run the simulation program as well as the procedures to follow in using the microcomputer hardware. The operations manual summarized the purpose and objectives of the simulation program. An outline of the general procedures for putting data into the program was presented and examples of input data were provided. Procedures for handling input errors were explained. Reports that should be obtained as the simulation program's output were described and examples shown.

Microcomputer Simulation Program

A microcomputer simulation program of food item inventory systems was utilized by the experimental group. The program was completed after the classroom educational modules. The program included two units: (1) simulation of a perpetual (fixed order) inventory system and (2) simulation of a periodic (fixed period) inventory system. The interactive characteristic of the simulation program permitted the participants to apply inventory management concepts presented in the educational modules. Options of the microcomputer program under the participants' control were: (1) selecting a fixed order inventory system, (2) selecting a fixed period inventory system, (3) changing the reorder point of a food item, (4) changing the reorder quantity of a food item, (5) subtracting (issuing) a food item from inventory, (6) ordering (replenishing) a food item, and (7) repeating either unit of the program as many times as desired.

Factors that were incorporated into the simulation program and not subject to the participants' control included: constant lead time; variable demand; predetermined ordering, stockout, and carrying costs; and total simulation time not to exceed 14 days. After each participant had reached a satisfactory solution for the case study problem, they completed a written study guide assignment (Appendix A, page 65) designed to aid the participants in organizing and evaluating data from the simulation program's printed reports. Also, each participant wrote a brief analysis describing the differences between the perpetual and periodic inventory systems and respective cost relationships.

Pretests and Posttests

Development of the multiple-choice pretests and posttests (Appendix B, page 82) was based on procedures recommended by Ahmann and Glock (62), Costin (63), Dick and Carey (64), Ebel (65), and Mager (66). The test was criterion-referenced which means the questions were derived from specific instructional objectives on inventory management (62, 64, 65). This type of test is particularly useful in determining which objectives and levels of cognition have been achieved by the student. The main advantage of using the multiple-choice format is its ability to test any level of cognitive educational achievement (62, 65). These levels are: knowledge, comprehension, application, analysis, synthesis, and evaluation (67). Thus, it can be used to determine how well a student can recall a specific item of information as well as apply basic principles to a new situation. This can be done without introducing the problem of subjective scoring which occurs in scoring essay or short-answer test items (7, 62). A disadvantage in writing multiple-choice tests is the difficulty in providing a suitable number of plausible responses to accompany the correct answer. Studies by Costin (63) have demonstrated that three-choice test items are as reliable and valid as four-choice items. Therefore, three-choice items were used in the pretests and posttests for this study. The questions also represented the six cognitive educational levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. There were 28 questions on each test with each question worth 1 point for a total possible score of 28 points. The same questions were used on both the pretest and posttest but were presented in a different sequence. Each test was coded with a number that later identified both the test and participant.

Collection of Demographic Data and Program Evaluation

A participant profile data sheet based on similar forms developed by West (7) and Vaughn (68) was used to collect information from each student. Information concerning age, gender, academic class standing, academic major, previous coursework in food systems management, previous work experience with inventories, and previous academic or work experience with computers (Appendix C, page 96). To ascertain the time spent on the microcomputer simulation assignment and the participants' opinion of the assignment, a written questionnaire (Appendix C, page 98) developed by Vaughn (68) was modified to meet the needs of this study. The questionnaire was composed of three sections. The first section was for the participants to estimate the amount of time used to complete the assignment. In the second section the participants responded to 10 questions regarding the microcomputer and its use in the course using a Likert scale. The scale ranged from "Strongly Agree," "Agree," "Undecided," "Disagree," to "Strongly Disagree." The third section required yes or no responses to 16 questions regarding clarity and ease of use of the simulation computer program, instructions manual, study guide, pretest, and posttest. The program evaluation data was collected after the computer simulation exercise was completed.

Statistical Evaluation

The statistical tools that were utilized to evaluate the pretest and posttest mean scores were the student's t-test and analysis of covariance (69). The student's t-test was used to determine if there was a significant difference ($P \leq .05$) in the pretest mean scores between the experimental and control groups. The analysis of covariance was used to determine if there was a significant difference ($P \leq .05$) in the posttest mean scores both within and between the experimental and control groups. The analysis of covariance has the capability to statistically control any effect the pretest performance may have on the posttest performance. Since performance on the posttest may be effected by performance on the pretest, the posttest performance cannot be solely attributed to the classroom educational modules and simulation experience. Therefore, the error variance in the final analysis can be reduced and any significant differences in the posttest mean scores will more likely be detected. Statistical analysis of the pretest and posttest scores was done using the computerized Statistical Package for the Social Sciences (SPSS) (70) and BMDP Statistical Software (71).

Pilot Studies

Two pilot sutdies were conducted to test the research instruments including the pretests and posttests, simulation program, and simulation program documentation for clarity and effectiveness. Faculty and students with academic backgrounds similar to those who were to participate in the actual research project were invited to test the research instruments. The time needed to complete the pretests, posttests, and simulation program was recorded and used as a guide in scheduling the appropriate amount of time for the research project. Results of both pilot studies were also used to revise the research instruments. Test scores were used to verify the correct choice of statistical techniques to analyze the data.

Research Project Procedures

All the participants in the research study were required to complete a student information sheet, pretest, and posttest while only the experimental group completed the microcomputer simulation. At the beginning of the winter academic term 1985-86 all the participants completed a Student Information Sheet (Appendix C, page 96). The participants also completed a pretest (Appendix B, page 83) to measure existing knowledge of inventory management principles and concepts. This was followed a week later by two fifty-minute classroom educational modules on inventory management. The members of the experimental group participated in a microcomputer simulation program of food item inventory systems. After completion of the program, the participants completed a study guide assignment (Appendix A, page 65) and Student Evaluation of Inventory Lecture/ Simulation (Appendix C, page 98). Both the experimental and control groups completed a posttest (Appendix B, page 89) approximately three weeks after the pretest. However, the control group did complete the simulation after the research period as a part of the classroom assignment. Upon completion of the microcomputer program, the control group was not posttested a second time but was asked to complete a Student Evaluation of Inventory Lecture/Simulation questionnaire. These evaluation data are included in the study.

RESULTS AND DISCUSSION

The purpose of this study was to teach management of perpetual and periodic inventory systems to university students in the field of food systems management through the use of a microcomputer software program developed for this purpose. The educational simulation program was based on a food item inventory written in Applesoft basic for the Apple IIe microcomputer. The objective of the study was to determine the classroom simulation's effectiveness in enhancing understanding of inventory systems management. The null hypothesis of this study was: there will be no significant difference ($P \leq .05$) in knowledge gained in inventory management techniques through the use of the microcomputer simulation between the persons who participate in the computer simulation exercise and the persons who do not.

The study was developed and tested in the Food Systems Management Department in the College of Home Economics at Oregon State University during the winter academic term, 1985-86. The population sample consisted of 68 seniors and graduate students enrolled in a Foodservice Procurement and Inventory Systems course. Through a simple random sampling procedure, the class members were divided into two groups: an experimental group (n = 34) and a control group (n = 34). Both groups completed a Student Information Sheet (Appendix C, page 96) and a pretest (Appendix B, page 83) which was followed a week later by two fifty-minute classroom educational modules on inventory management. The students in the experimental group participated in a microcomputer simulation program of food item inventory systems. After completion of the program, the participants completed a study guide assignment (Appendix A, page 65) and Student Evaluation of Inventory Lecture/Simulation (Appendix C, page 98). Both the experimental and control groups completed a posttest (Appendix B, page 89).

Data were collected in three areas: (1) student demographic information, (2) pretests and posttests, and (3) student evaluation of the simulation program assignment. Demographic data were requested in order to provide a descriptive profile of the research participants. Pretest and posttest scores were the result of a 28 question multiple-choice test on inventory management topics. Evaluation of the simulation program assignment was done to determine the participants' opinion of the instructional materials. Statistical analysis of the pretest and posttest scores was done using the computerized Statistical Package for the Social Sciences (SPSS) (70) and BMDP Statistical Software (71).

Demographic Data

The demographic data were collected from a student information questionnaire (Appendix C, page 96). Data were requested in three areas: personal profile, academic coursework, and work experience with inventories.

Personal Profile Data

Personal profile data included age, gender, academic class standing, and academic major. In Figure 1 (page 37) 56 percent of the

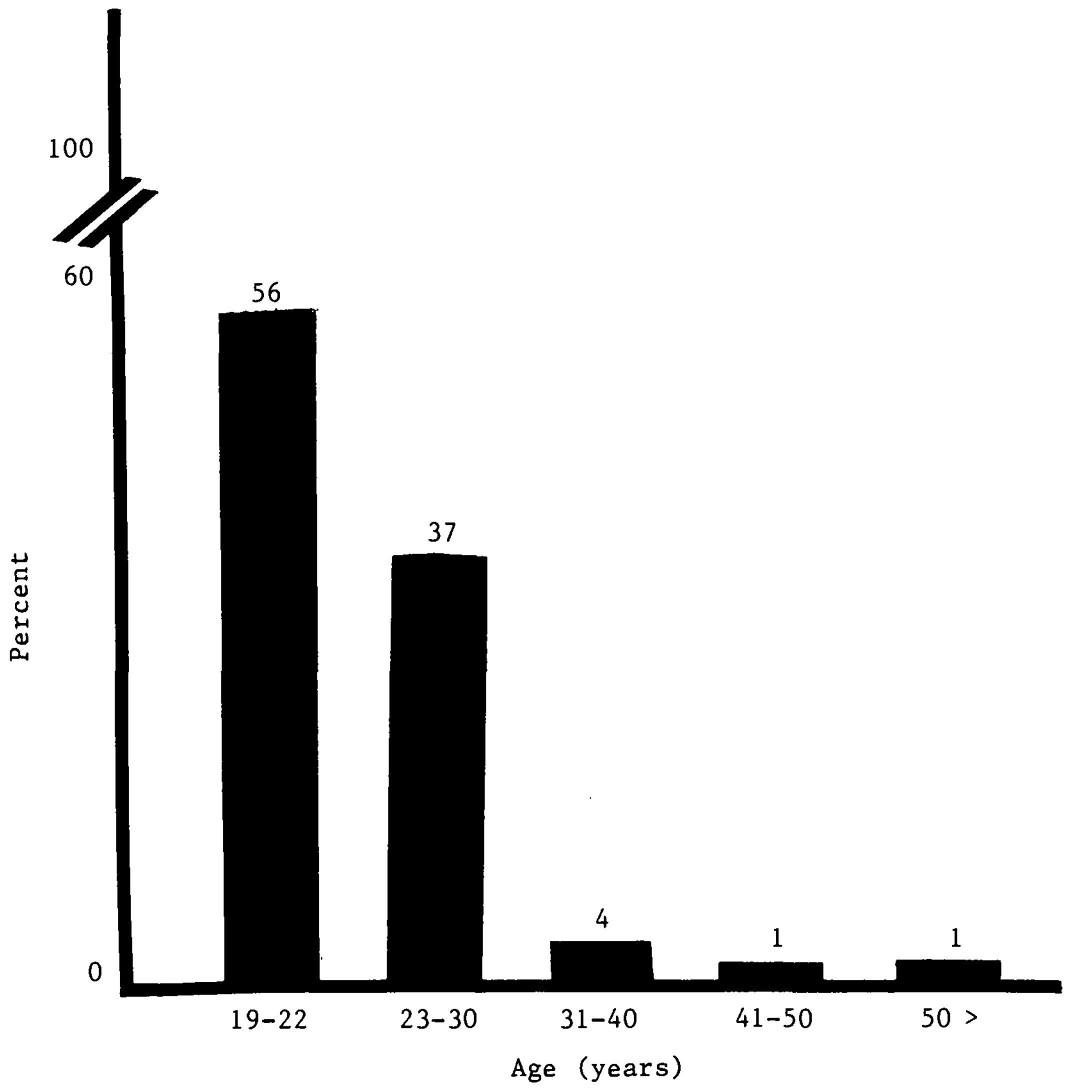

Figure 1

Percent Distribution of Ages
of Total Sample of 68 Participants
in the Inventory Simulation Study

participants were in the age range of 19-22 years; 37 percent of the participants were in the 23-30 year age range; 4 percent of the participants were in the age range of 31-40 years; 1 percent of the participants were in the 41-50 year age range; and 1 percent in the 51 and over age range. Seventy-five percent of the participants were female and 25 percent were male. Eighty-eight percent of the participants were seniors, 4 percent post-baccalaureate, 4 percent graduate students, and 3 percent were classified as special students. Thirty-five percent of the participants (Figure 2, page 39) were food systems management/dietetic majors (FSM/D), 56 percent were hotel/restaurant/tourism management (HRTM) majors, 3 percent in health care administration (HCA), and 4 percent in other majors such as business and home economics education and communications.

Academic Coursework and Work Experience

Responses regarding academic coursework and work experience were as follows. Ninety-one percent of the research population had some foodservice-related work experience. Food item or related inventory work experience included participants with: 38 percent ordering, 41 percent receiving, 43 percent storing, and 29 percent issuing. Eighty-one percent of the participants had taken one or more courses which included computer programming but only 3 percent of the students had used a computer to process inventories in either academic coursework or in work experience. Many of the participants misinterpreted questions five through ten on the Student Information

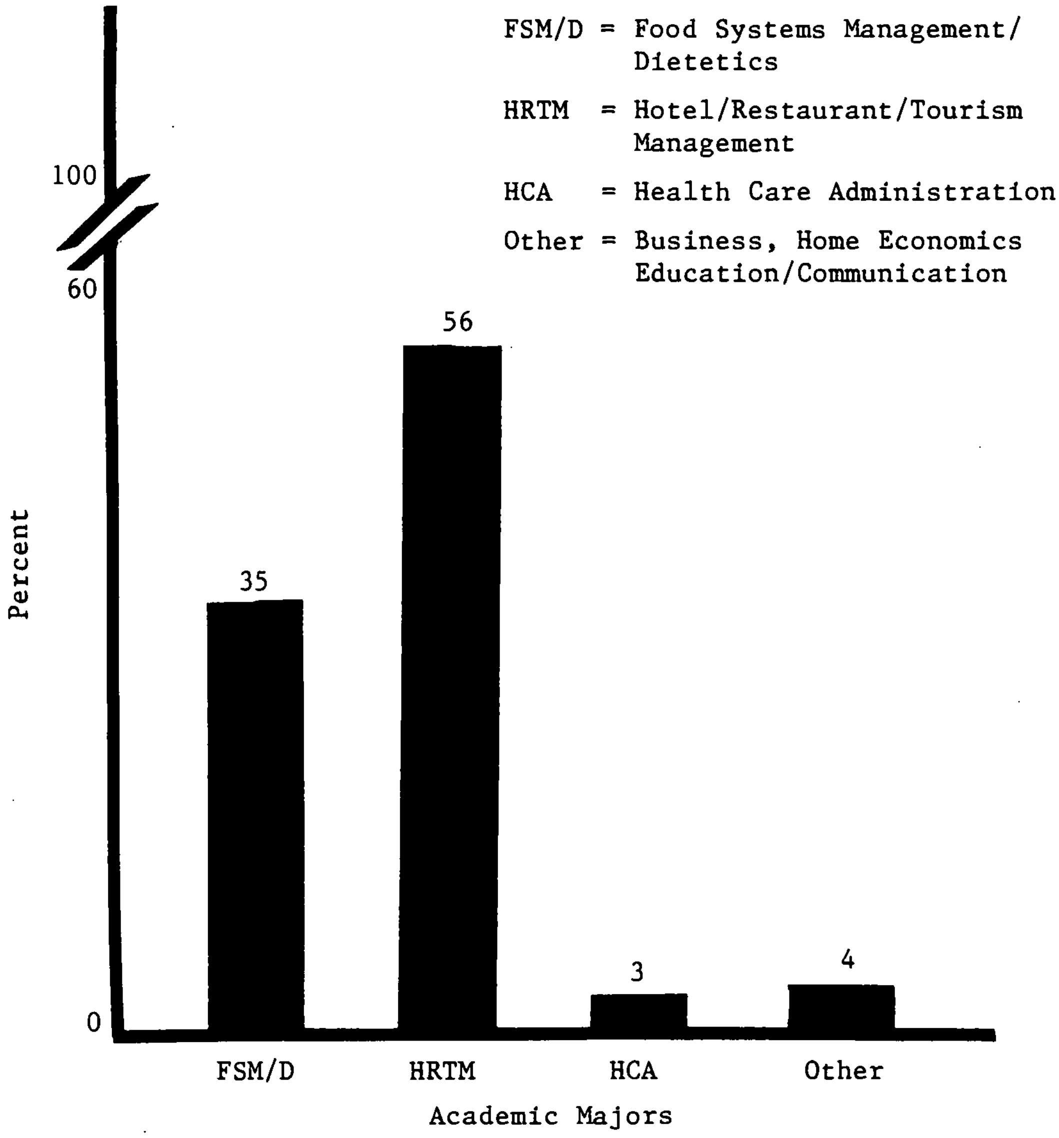

Figure 2

Percent Distribution of Academic Majors of Total Sample of 68 Participants in the Inventory Simulation Study

Sheet (Appendix C, page 96). The responses to those questions were not reported in these results.

Statistical Analysis

For this research study, the student's t-test and analysis of covariance were used to evaluate the pretest and posttest mean scores. The student's t-test was used to determine if there was a significant difference ($P \leq .05$) in pretest mean scores between the experimental and control groups in initial knowledge of inventory management at the beginning of the study. The analysis of covariance was used to determine if there was a significant difference ($P \leq .05$) in posttest mean scores between the experimental and the control groups at the end of the study.

Pretest Scores

Differences in pretest mean values, percent, standard error, and student's t between the experimental and control groups were not significant ($P \leq .05$) as determined by the student's t-test (Table 1, page 41) as the values were nearly identical, i.e., the mean was 15.2 points (54.3 percent) for the experimental group and 15.1 points (53.8 percent) for the control group. The results indicated that the two groups were similar to each other in previous knowledge of inventory management at the beginning of the study. There were 28 multiple-choice questions on each test (Appendix B, page 82) with each question worth 1 point for a total possible score of 28 points.

Table 1

COMPARISON BY STUDENT'S T-TEST OF MEAN SCORES OF EXPERIMENTAL AND CONTROL GROUPS ON THE PRETEST

Group	Mean	Percent	Standard Error	Student's t
Experimental (n = 34)	15.2*	54.3	0.40	0.26†
Control (n = 34)	15.1*	53.8	0.40	0.26†

* maximum score was 28 points
† not significant at ($P \leq .05$) level

Posttest Scores

The difference in adjusted mean scores on the posttest between the experimental and control groups was significant at the $P \leq .05$ level as determined by analysis of covariance (Table 2).

Table 2

COMPARISON BY ANALYSIS OF COVARIANCE OF MEAN SCORES OF EXPERIMENTAL AND CONTROL GROUPS ON THE POSTTEST

Group	Mean	Adjusted Mean	Percent	Standard Error
Experimental (n = 34)	18.5*	18.4	65.9	0.42†
Control (n = 34)	17.0*	17.1	60.9	0.42†

* maximum score was 28 points
† was significant at ($P \leq .05$) level

The posttest mean, adjusted mean, percent, and standard error indicated that the two groups were different from each other in amount of knowledge change at the end of the study. The analysis of covariance was used to statistically control any effect the pretest performance might have had on the posttest mean scores. The posttest adjusted mean score for the experimental group was 18.4 points (65.9 percent) and the posttest adjusted mean score for the control group was 17.1 points (60.9 percent). The posttest was the same as the pretest with a different sequence of questions. There was a total possible score of 28 points with 1 point for each question (Appendix B, page 89).

Further analysis of the posttest adjusted mean scores was done by calculating the F-value (Table 3).

Table 3

ANALYSIS OF COVARIANCE OF MEAN SQUARES FOR POSTTEST

Source of Variance	Mean Squares	df	F-value	Probability
Between groups	32.5049	1	5.3754	.02*
Within groups	6.0470	65		

* was significant at ($P \leq .05$) level

Descriptive Evaluation of Pretest and Posttest Scores

A descriptive evaluation of the pretest and posttest scores was conducted of both the experimental and control group participants.

The knowledge change indicated by the number of points gained, remained the same, or lost on the results of the multiple-choice tests was compiled and presented in Table 6, Appendix D, page 101. For example, participant number one of the experimental group had a pretest score of 19 points out of a total possible maximum score of 28. When the pretest score was compared to the posttest score of 21 points, a 2 point gain in knowledge was indicated. Participant number thirty-five of the control group had a pretest score of 16 points and a posttest score of 22 points for a net gain of 6 points.

The lowest and highest scores of the participants on the pretest and posttest were compared for each group in Table 6, Appendix D, page 101. The lowest score (*) on the experimental group pretest was 10 points and the highest score (†) was 19 points. The lowest score (‡) on the experimental group posttest was 13 points and the highest score (#) was 23 points. The lowest score (¶) on the control group pretest was 10 points and the highest score (‖) was 20 points. The lowest score (**) on the control group posttest was 12 points and the highest score (††) was 23 points.

The average point gain from pretest to posttest for each group was compared (Figure 3, page 44). The experimental group (n = 34) showed a gain in points for 79 percent of the participants while the control group (n = 34) showed a gain in points for 64 percent. The percentage of participants who remained the same or lost points from pretest to posttest scores were compared for both groups of participants. Twelve percent of the experimental group remained the same while

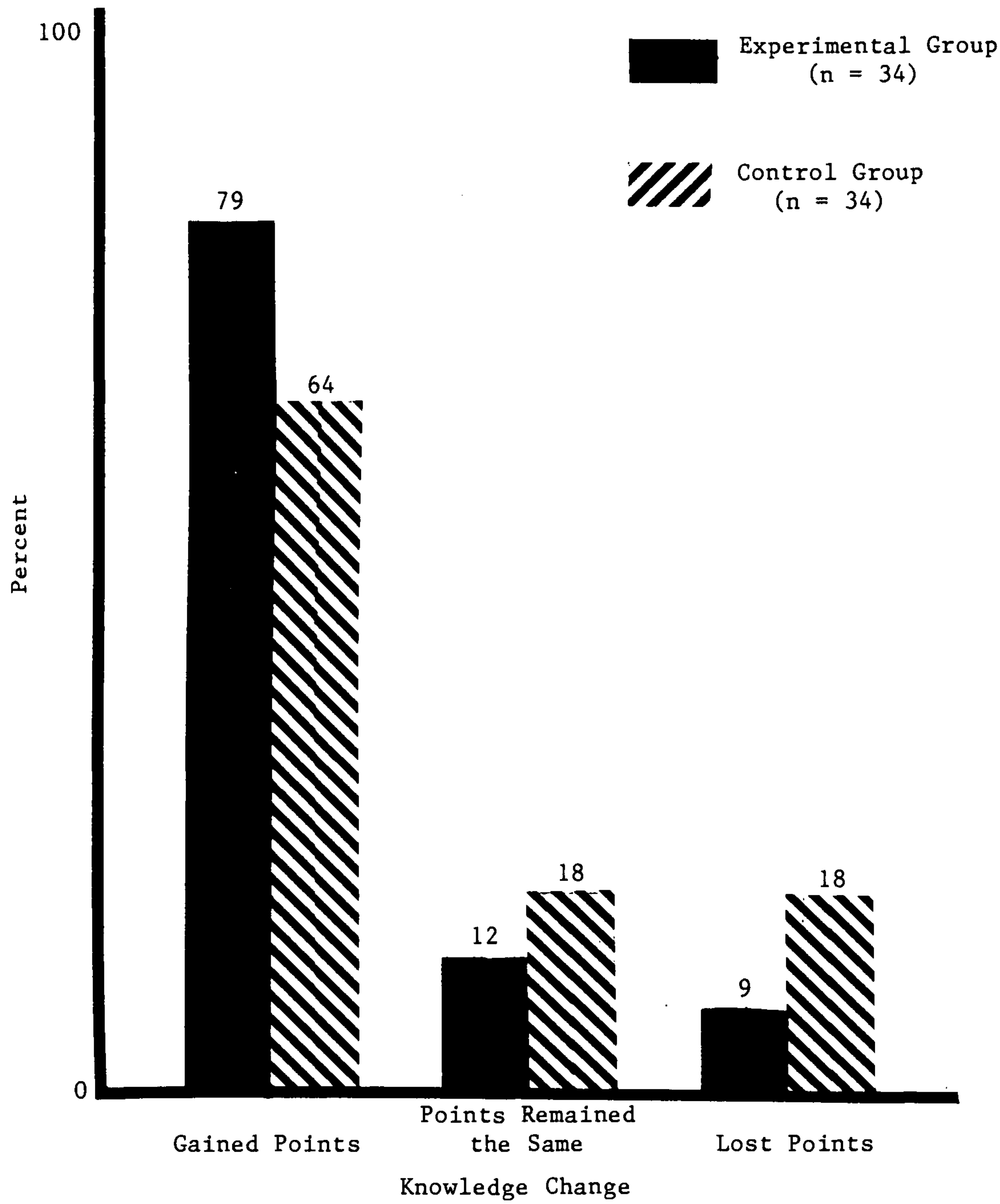

Figure 3

Percentage of Points Gained, Remained the Same, or Points Lost from Pretest to Posttest for the Experimental and Control Groups in the Inventory Simulation Study

18 percent of the control group remained the same from pretest to posttest. Nine percent of the experimental group lost points on the posttest while 18 percent of the control group lost points. A comparison of the pretest scores and the posttest scores for both groups (n = 68) demonstrated improvement for 72 percent of the participants. The average point gain for the experimental group was 3 points (11 percent). The average point gain for the control group was 2 points (7 percent).

Student Evaluation of Simulation Program Assignment

To ascertain the students' opinion of the simulation program assignment, a written questionnaire was developed (Appendix C, page 98). The questionnaire was composed of three sections. The first section was for the participants to estimate the amount of time used to complete the assignment. The second section had the participants respond to ten questions regarding the microcomputer and its use in the course. The third section required responses to sixteen questions regarding clarity and ease of use of the instructional materials.

Time

The length of time for the participants to complete the computer simulation and study guide assignment was recorded. For simulation time (Figure 4, page 46) 32 percent of the participants used one hour or less to complete the microcomputer simulation program, 59 percent took two hours, and 9 percent took three hours.

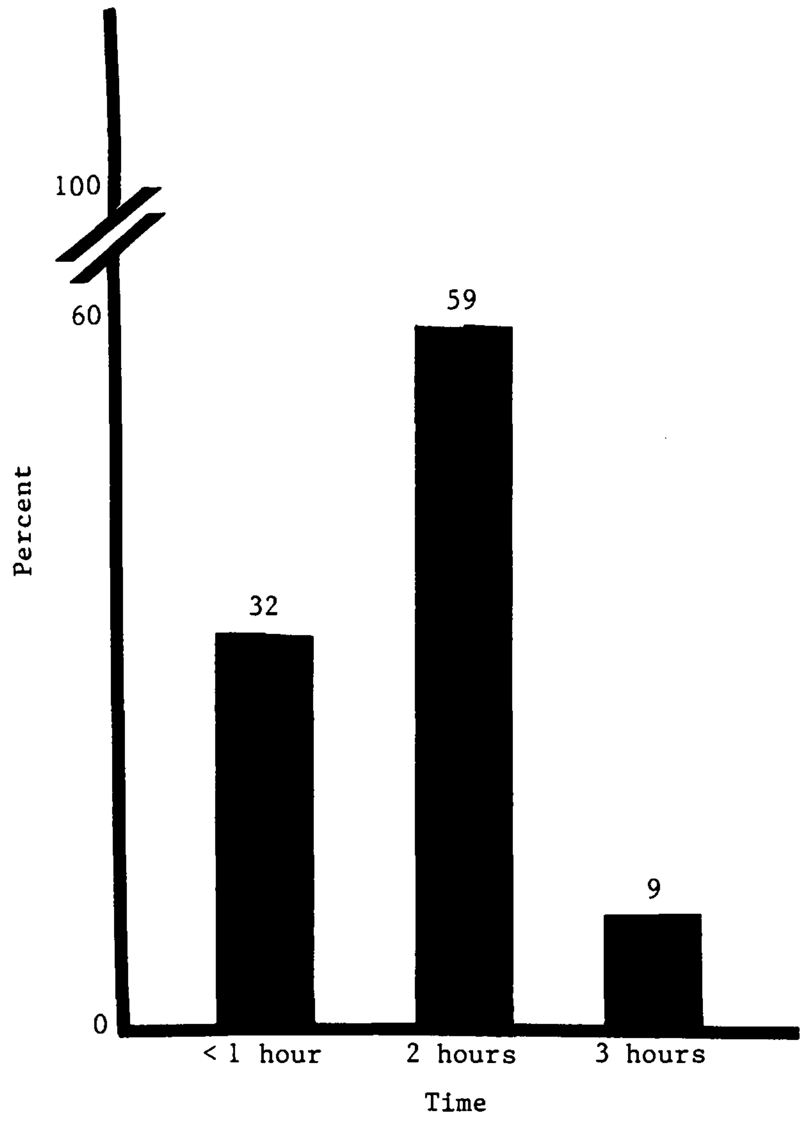

Figure 4

Percent Distribution of Time to Complete
the Microcomputer Inventory Simulation Program
by the Total Sample of 68 Participants

For study guide time (Figure 5, page 48) 75 percent of the participants required one hour to complete the accompanying study guide assignment. Twenty-two percent needed two hours to complete the study guide and 3 percent needed three hours. In summary, the total time needed to complete both the computer exercise and written assignment was three hours.

Participants' Attitude Towards Microcomputers

The participants' attitude towards microcomputers and their incorporation into the food systems management class was obtained from the Student Evaluation of Inventory Lecture/Simulation (Appendix C, page 98) and documented in Table 4, page 49. The percentage of responses were positive, ranging from 50 to 90 percent, for nine of the ten questions. For example, the combined responses to question four in the strongly agree and agree categories indicated that 90 percent of the participants felt the computer was an important part of learning to manage foodservice inventories. Combining the responses to question five in the strongly disagree and disagree categories indicated that 62 percent of the participants felt that the workload for the course was not greatly increased by including the microcomputer simulation exercise. Only for question six were the responses almost equally divided between those who strongly agreed/agreed (35 percent) and those who strongly disagreed/disagreed (38 percent) that using the microcomputer materials made them more interested in inventory management.

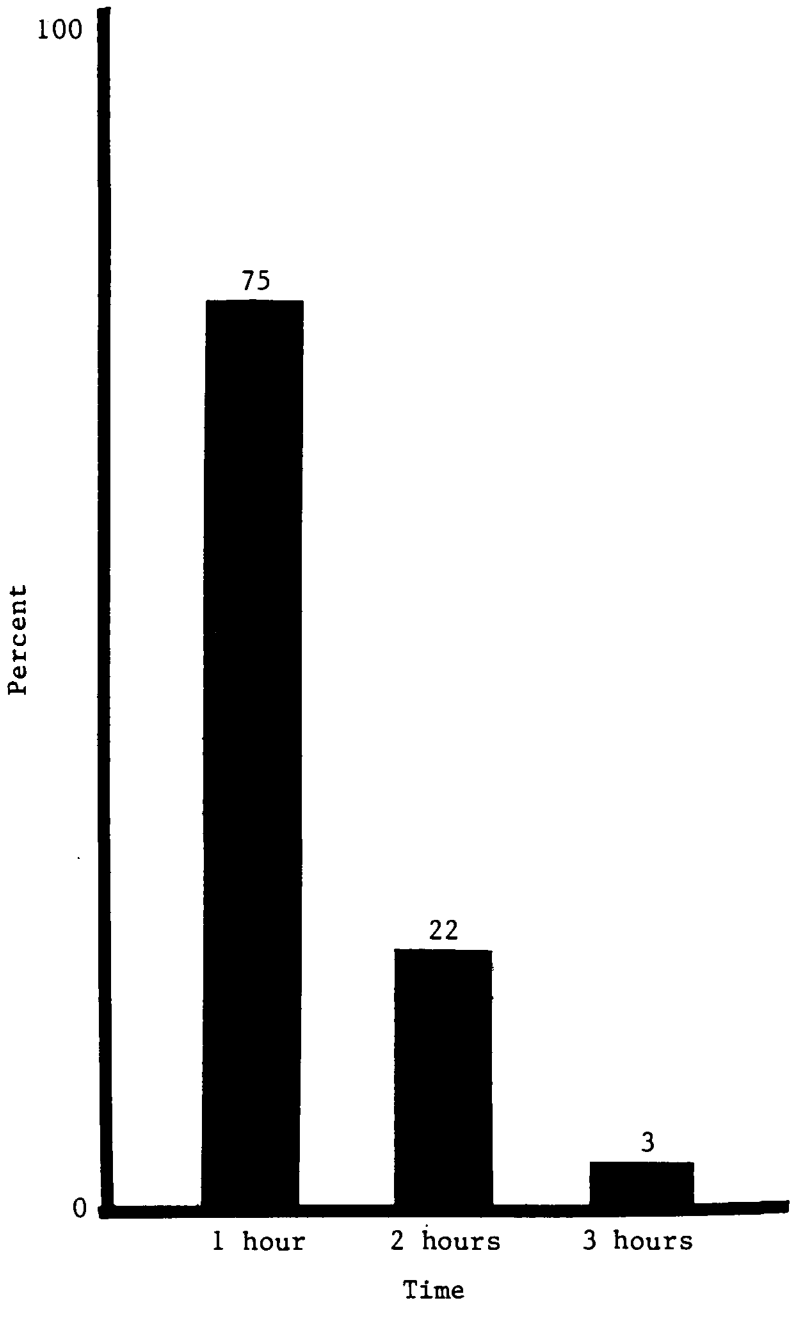

Figure 5

Percent Distribution of Time
to Complete the Study Guide
by the Total Sample of 68 Participants

Table 4

STUDENT EVALUATION OF MICROCOMPUTER ASSIGNMENTS: PERCENT RESPONSES

Question Number		Individual Percent: Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Summary Percent: Strongly Agree Plus Agree	Strongly Disagree Plus Disagree
4.	The computer is an important part of learning to manage foodservice inventories.	40	50	6	1	3	90	4
5.	My workload for this course was greatly increased by including the microcomputer simulation exercise.	4	12	22	50	12	16	62
6.	The concepts I learned using the micro-computer materials made me more interested in inventory management.	9	26	26	29	9	35	38
7.	I was apprehensive of the technical diffi-culties in using the microcomputer.	10	22	12	26	29	32	55
8.	When I enroll in another food systems manage-ment course I would prefer that computer materials be included.	18	44	28	4	4	62	8
9.	Learning how to use the microcomputer distracted from the study of foodservice inventory management.	1	9	10	47	32	10	79
10.	From taking this course I would like to know more about how computers may be used in other areas of food systems management.	37	35	12	12	4	72	16
11.	Computer instruction is just another step toward depersonalized instruction.	1	8	12	50	26	9	76
12.	I found using the microcomputer in this course to be inefficient use of my time.	10	19	13	48	9	29	57
13.	I feel the microcomputer materials were a valuable addition to this course.	13	37	25	20	4	50	24

Participants' Evaluation of Instructional Materials

Results of the participants' evaluation of the instructional materials from the Student Evaluation of Inventory Lecture/ Simulation (Appendix C, page 98) was compiled in Table 5, page 51. Responses for all 16 questions were positive, ranging from 51 to 93 percent. For example, in response to question fourteen, 78 percent of the participants believed the pretest and posttest instructions and questions were written in clear terms that were easily understood.

Table 5

STUDENT EVALUATION OF PRETESTS AND POSTTESTS, OPERATIONS MANUAL, COMPUTER PROGRAM, AND STUDY GUIDE; PERCENT YES/NO RESPONSES

Question Number		Percent Yes	Percent No
14.	The pre/post tests instructions and questions were written in clear terms that were easily understood.	78	21
15.	The pre/post test questions increased my understanding of inventory management concepts.	53	44
16.	The pre/post tests were adequate in covering the topic of computer-assisted inventory management.	71	25
17.	The simulation operations manual was written in clear terms that were easily understood.	51	46
18.	The simulation operations manual was well organized.	65	31
19.	The simulation operations manual was adequate in explaining how to correct input errors and prevent the program from stopping during use.	69	31
20.	The microcomputer inventory simulation program was easy to use.	66	31
21.	The microcomputer inventory simulation program was easily understood.	63	34
22.	The microcomputer inventory simulation program added to my understanding of inventory management.	69	29
23.	The microcomputer inventory simulation program was boring.	38	57
24.	The microcomputer inventory simulation program would be a good way to provide inventory management experience to students when actual on-the-job experience is not practical or available.	82	16
25.	The microcomputer inventory simulation program did not take too much time to use.	71	28
26.	The study guide instructions were written in clear terms that were easily understood.	68	31
27.	The study guide assignment was well organized.	76	21
28.	The study guide assignment enhanced my understanding of the microcomputer inventory simulation program.	62	35
29.	The study guide assignment did not take too much time to complete.	93	7

SUMMARY AND CONCLUSIONS

A review of the literature indicated that research into computer-assisted food systems management has been conducted for the past twenty-five years. Frequently, only large teaching hospitals and universities with expensive mainframe computers had the opportunity to utilize this powerful management tool in either education or operations management. During recent years the proliferation of less expensive microcomputers has made it possible for the majority of foodservice managers to realize the benefits of computer technology.

Professional organizations, such as the Foodservice Systems Management Education Council, have long recognized and recommended the use of computer-assistance in food systems management as a required competency for entry level dietitians. However, only a few mainframe programs were available to meet this educational need. With the increased utilization of microcomputers in foodservice operations management, the need to provide educational opportunties for students to gain computer competency skills has become greater. The opportunity for computer applications in the academic setting has been limited by the scarcity of appropriate microcomputer software programs.

The purpose of this study was to teach management of perpetual and periodic inventory systems to university students in the field of food systems management through the use of a microcomptuer software program developed for this purpose. The objective of this study was to determine the classroom simulation's effectiveness in enhancing understanding of inventory systems management.

The research population sample consisted of 68 students enrolled in a senior level food systems management course at Oregon State University. Demographic data were collected regarding age, gender, academic class standing and major, academic coursework, and work experience with inventories in order to provide a descriptive profile of the research participants. The majority of students were 19 to 30 years of age, female, and seniors in either food systems management/dietetics or hotel/restaurant/tourism management. Though 91 percent of the participants reported foodservice related work experience and 81 percent had had academic courses which included computer programming, only 3 percent had ever used a computer for inventory management.

Simple random sampling was used to divide the population sample into two groups: an experimental group (n = 34) and a control group (n = 34). All the participants completed a pretest to measure existing knowledge of inventory management concepts. This was followed by two fifty-minute classroom educational modules on the management of perpetual and periodic inventory systems in foodservice facilities. The members of the experimental group participated in using the microcomputer simulation program of food item inventory systems after the classroom modules were presented. All the participants of the experimental and control groups completed a posttest approximately three weeks after the pretest.

A comparison of the pretest and posttest mean scores between the experimental and control groups was made. The difference in the pretest mean score for the experimental group at 54.3 percent and for the control group at 53.8 percent, was not significant ($P \leq .05$) as determined by the student's t-test. This indicated the two groups were similar to each other in previous knowledge of inventory management. The posttest adjusted mean score for the experimental group was 65.9 percent and for the control group was 60.9 percent. The difference in posttest adjusted mean scores between the experimental and control groups was significant ($P \leq .05$) as determined by analysis of covariance. Further analysis of the posttest adjusted mean scores was done by calculating the F-value. This test also indicated a significant difference ($P \leq .05$) in the posttest adjusted mean scores of the experimental and control groups.

Student evaluation of the simulation assignment indicated that the average amount of time needed to complete both the computer exercise and written assignment was three hours. The participants' response towards microcomputers and their incorporation into the food systems management class was generally positive, ranging from 50 to 90 percent. The participants' responses in evaluating the instructional materials was also generally positive, ranging from 51 to 93 percent indicating that the computer simulation program, instructions manual, study guide, pretest, and posttest were clear, well organized, easy to understand, and to use.

In conclusion, the microcomputer simulation was effective in enhancing students' understanding of the management of perpetual and periodic inventory systems. The statistical analysis of the pretest mean scores by the student's t-test indicated no significant difference between the experimental and control groups in initial knowledge of inventory management at the beginning of the study. However, there was a significant difference ($P \leq .05$) in the posttest adjusted mean scores as determined by analysis of covariance. There was greater improvement of the experimental group over the control group in knowledge gained at the end of the study. This may be assumed to be due to the use of the computer simulation program by the experimental group. Therefore, the results of this study permit the rejection of the null hypothesis that there is no significant difference at the $P \leq .05$ level in the knowledge gained in inventory systems management through the use of microcomputer simulation between the persons who participate in the computer simulation exercise and those who do not. The overall research resulted in a positive experience for the participants based on the responses to questions in the Student Evaluation of the Inventory Lecture/ Simulation. A concurrent outcome for the participants in the study was the additional time and experience spent in effectively using microcomputer equipment in a practical applications situation. The learning of the participants was enhanced by the inclusion of the computer simulation in the coursework.

RECOMMENDATIONS

The results of this study indicate that microcomputer simulations of food item inventories was effective in enhancing students' understanding of inventory management concepts. Therefore, it is recommended that microcomputer programs be used to simulate inventory subsystems of foodservice facilities in the classroom. It is recommended that foodservice industry professionals provide leadership in coordinating with computer programming personnel the development of microcomputer software simulations for classroom instruction. It is also recommended that other interrelated areas of a foodservice operation have microcomputer simulations provided in the classroom instruction. Some of the areas that might be simulated are: production, formal bid purchasing, marketing, cost accounting, labor scheduling, and kitchen design. It is also recommended that further investigation be done in adapting existing food systems management computer programs or microcomputer applications software into simulations programs for classroom use.

It is advised if the study is replicated that the following modifications be made to insure smooth implementation of the assignment into the coursework. First, the computer simulation program could be divided into one hour segments instead of the two hour time frame. The smaller one hour modules could be completed at regular intervals throughout the academic term. Second, a supervised computer lab is necessary to provide technical support in operating the computer hardware and software program. Third, it would be desirable to develop additional inventory case studies specific to various foodservice facilities and student career interests in order to provide a variety of operational situations for problem solving. Fourth, the possibility of modifying the existing simulation assignment for other teaching arenas, such as community colleges or individual study, should be considered.

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APPENDICES

APPENDIX A

Perpetual Inventory Simulation Study Guide
and Data Summary Sheet

Operations Manual

Perpetual Inventory Simulation Study Guide and Data Summary Sheet

Soc. Sec. # ______________________________ Date ________________

PERPETUAL INVENTORY SIMULATION STUDY GUIDE AND DATA SUMMARY SHEET

Computer Time		Study Guide Time	
Time Stop Hr:______	Min:______	Time Stop Hr:______	Min:______
Time Start Hr:______	Min:______	Time Start Hr:______	Min:______
Total Time Hr:______	Min:______	Total Time Hr:______	Min:______

Complete the following questions for the perpetual (fixed order quantity) inventory system based on the printout from your simulation.

1. Plot the demand from the printout on the attached graph paper.

   What was the highest demand for the two weeks (14 days)? _____
   What was the lowest demand for the two weeks ? ______________
   What was the average demand for the two weeks? ______________

2. Can you see any pattern to the demand? ______________________
   ____

   Could you use any forecasting method(s) here? ______________
   ____

3. What were the beginning and ending inventory levels for each item?

	Beg Inv	End Inv
Hamburger patties		
Sesame Buns		
French Fries		
Fizzy Soda		

4. How many total order transactions were placed for each item during the two weeks? How many total units were ordered for each item? What were the total ordering costs?

	# of Orders	# of Units	Cost of Orders
Hamburger patties			
Sesame Buns			
French Fries			
Fizzy Soda			
TOTAL			

What was the total ordering cost for the two weeks? ____________

5. What was the reorder point and reorder quantity for each item?

	Reorder Point	Reorder Quantity
Hamburger patties		
Sesame Buns		
French Fries		
Fizzy Soda		

6. Were there any stockouts during the two weeks? If yes, which items were you out of stock? How many days? What was the cost?

	# days out	# units out	STKO cost
Hamburger patties			
Buns			
Fries			
Fizzy Soda			
TOTAL			

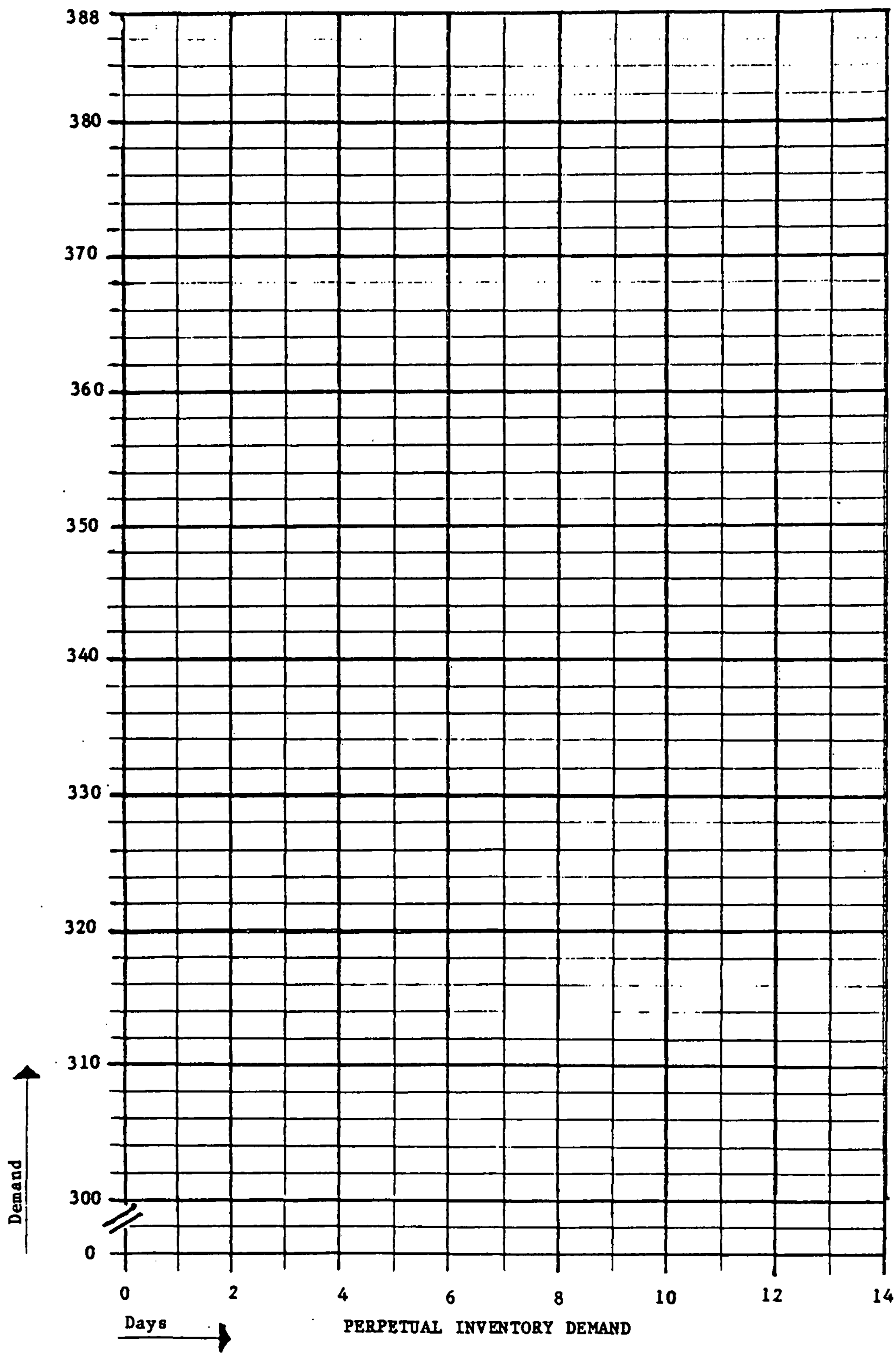
What was the total stockout cost for the two weeks?____________

7. What was the total holding cost for the two weeks? ____________

8. What was the total of all costs for the two weeks? ____________

PLEASE WRITE YOUR SOCIAL SECURITY NUMBER ON ALL YOUR DOCUMENTS. THEN RETURN ALL OF THE FOLLOWING:

1. Simulation Manual
2. Study Guides
3. Graphs
4. Computer Printouts



PERPETUAL INVENTORY DEMAND

Soc. Sec. # ______________________________ Date ________________

PERIODIC INVENTORY SIMULATION STUDY GUIDE
AND DATA SUMMARY SHEET

Computer Time
Time Stop Hr:______ Min:______
Time Start Hr:______ Min:______
Total Time Hr:______ Min:______

Study Guide Time
Time Stop Hr:______ Min:______
Time Start Hr:______ Min:______
Total Time Hr:______ Min:______

Complete the following questions for the periodic (fixed order period) inventory system based on the printout from your simulation.

9. Plot the demand from the printout on the attached graph paper.

What was the highest demand for the two weeks (14 days)? _____
What was the lowest demand for the two weeks? ________________
What was the average demand for the two weeks? _______________

10. Can you see any pattern to the demand? ________________________
____

Could you use any forecasting method(s) here? ________________
____

Is the demand similar to or different from the demand for the perpetual inventory simulation? In what way? ________________
____
____

11. What were the beginning and ending inventory levels for each item?

	Beg Inv	End Inv
Hamburger patties		
Sesame Buns		
French Fries		
Fizzy Soda		

12. How many total order transactions were placed for each item during the two weeks? How may total units were ordered for each item? What were the total ordering costs?

	# of Orders	# of Units	Cost of Orders
Hamburger patties			
Sesame Buns			
French Fries			
Fizzy Soda			
TOTAL			

What was the total ordering cost for the two weeks? ____________

13. What was the par level and reorder quantities for each item?

	Reorder Point	Reorder Quantity I	Reorder Quantity II
Hamburger patties			
Sesame Buns			
French Fries			
Fizzy Soda			

14. Were there any stockouts during the two weeks? If yes, which items were you out of stock? How many days? What was the cost?

	# days out	# units out	STKO cost
Hamburger patties			
Sesame Buns			
French Fries			
Fizzy Soda			
TOTAL			

What was the total stockout cost for the two weeks? ___________

15. What was the total holding cost for the two weeks? ___________

16. What was the total of all costs for the two weeks? ___________

17. **Which inventory system (perpetual or periodic) has the lower holding, ordering, stockout, and total costs?** ________________

____

Is there a relationship between these costs? Explain. ________

____

____

____

____

____

18. **Which inventory system (perpetual or periodic) is preferred in this situation and why?**

____

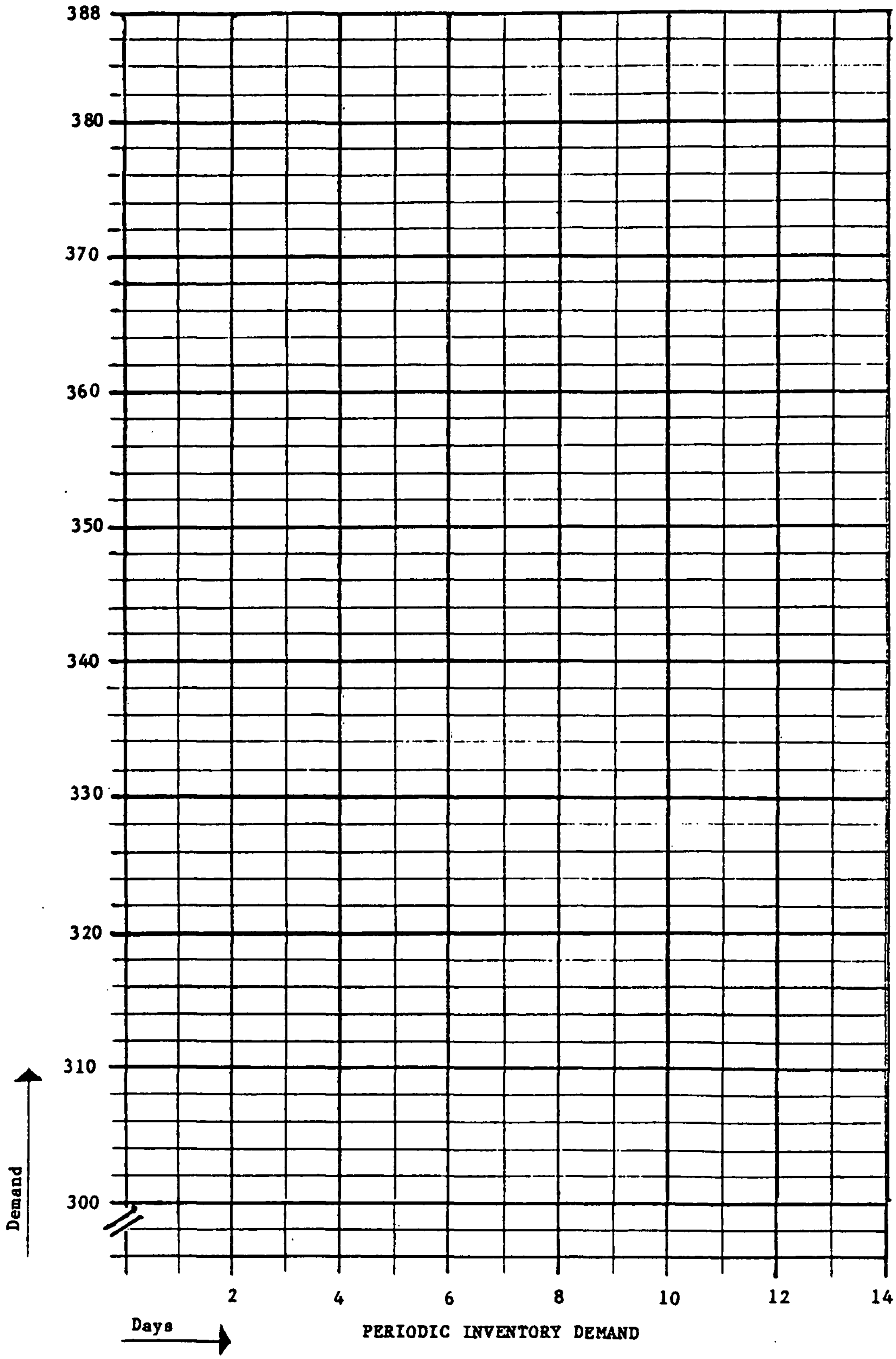
____

____

____

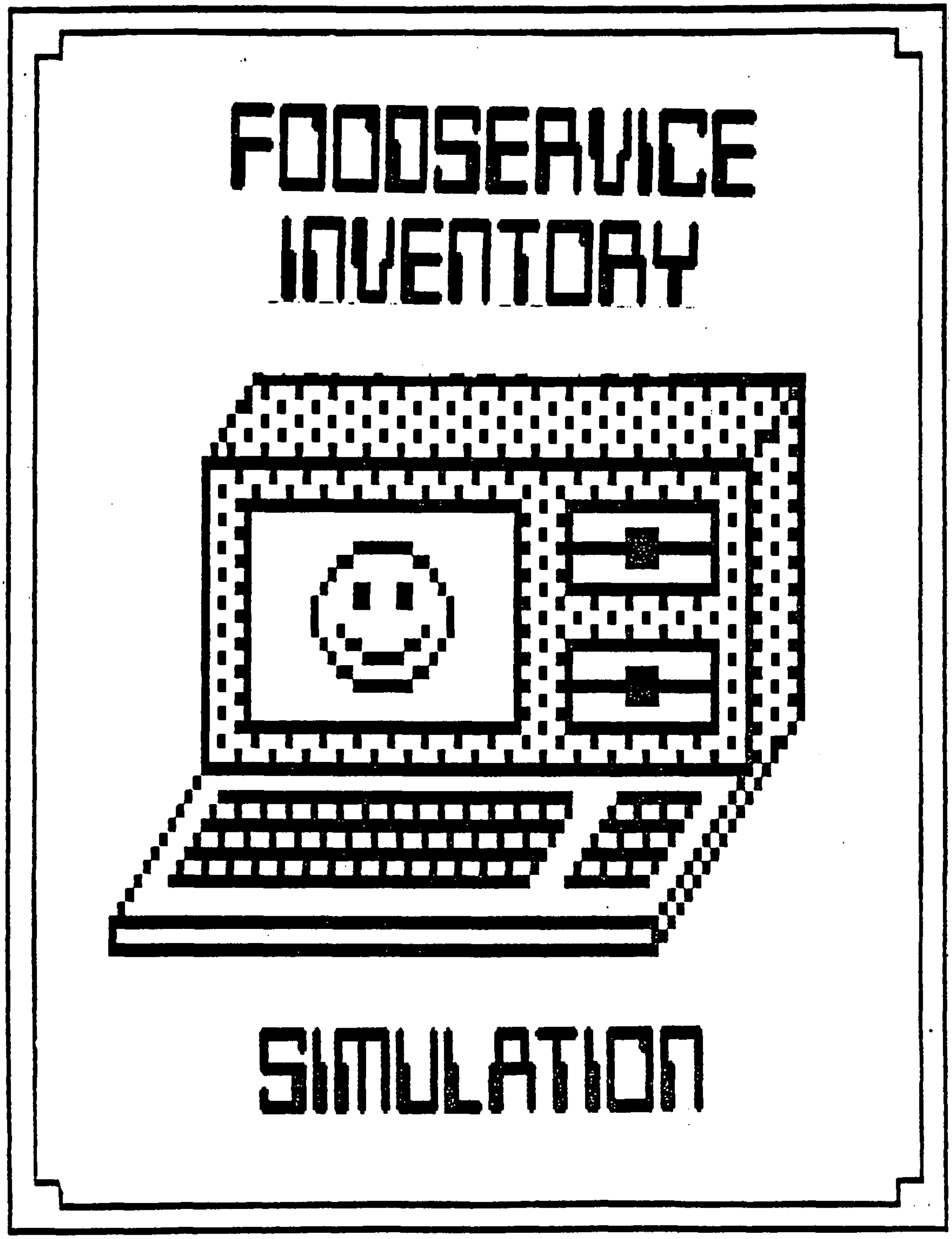
PLEASE WRITE YOUR SOCIAL SECURITY NUMBER ON ALL YOUR DOCUMENTS. THEN RETURN ALL OF THE FOLLOWING:

1. **Simulation Manual**
2. **Study Guides**
3. **Graphs**
4. **Computer Printouts**



PERIODIC INVENTORY DEMAND

Operations Manual



FOODSERVICE INVENTORY SIMULATION
OPERATIONS MANUAL

Barbara Cloninger, R.D.
Winter 1986

DESCRIPTION: Foodservice Inventory Simulation is a computer software program designed as an educational tool for learning inventory management skills. It employs an interactive simulation process, allowing the user to perform a variety of transactions in keeping inventory records current and updated.

LEARNING OBJECTIVES:

1. Recognize and use appropriate inventory terminology
2. Determine when and how much of a food item to order
3. Determine when and how much of a food item to issue
4. Demonstrate understanding of the relationship between ordering, holding, and stockout costs
5. Evaluate the advantages and disadvantages of the perpetual and periodic inventory systems

HARDWARE REQUIREMENTS:

Apple II or IIe, 64K
One 5-1/4 inch floppy disk drive, DOS 3.3
Monochrome Monitor
Prowriter Model 8510 Printer or similar printer is required with the interface card in slot number one.

OPERATING INSTRUCTIONS:

1. Please read through this operations manual before activating the simulation program on computer disk.

2. To start the Foodservice Inventory Simulation, hold the floppy disk by the labeled end, label up, insert it into the disk drive, close the door on the disk drive and turn the system on. From this point on, additional procedural instructions will be printed on the monitor screen and should be self-explanatory.

OPERATING TIPS:

1. The computer disk must remain in the disk drive for the program to be functional as it is accessed continually throughout any program run. Never try to insert or remove the disk when the red light on the disk drive is lit up. This can result in damage to the disk.

2. The caps lock key must be pressed down into the locked position or the program will not run.

3. Always press "return" after responding to a data request.

4. When asked to supply a yes or no response (Y/N), enter "Y" for yes and "N" for no and press "return".

5. If a typing error has been made in entering data and the "return" key has not been pressed, the key marked with an ← will backspace the cursor. After the "return" key has been pressed, corrections must be made by following the instructions on the screen.

6. The numeral keys on the upper keyboard must be used to input numbers. The lowercase letter "l" and uppercase letter "O" cannot be used for the numerals one (1) and zero (0). Using these letters will result in errors in the data.

7. Attempts to print information requiring a printer when a printer is not available will cause the program to stop. If this occurs, the program must be reloaded by turning off the system and turning it back on again. This will result in the loss of some data. When using the printer, be sure it is turned on and the "sel" or green ready light it lit up. Check to see that the paper is threaded throught the printer correctly It will take at least ten sheets of continuous 8 1/2 " x 11" paper to run the program.

INFORMATION & INTRODUCTION: The user should become familiar with the inventory terms and review the case study problem carefully before using the simulation program on the computer disk.

GLOSSARY OF INVENTORY TERMS

1. Demand - in foodservice operations, a customer order for a particular product

2. Issue - to pull an item from a location in inventory and move it to its destination

3. Buffer stock - a quantity of stock planned to be in inventory to protect against fluctuation in demand and/or supply

4. Perpetual inventory system - an inventory system in which the size of the order is fixed, but the time interval between orders varies with demand (also known as the fixed order quantity inventory system)

5. Periodic inventory system - an inventory system in which the time interval between orders is fixed, but the order size varies with demand (also known as the fixed order period inventory system)

6. Leadtime - the time interval between ordering and receiving stock into inventory

7. Reorder point - the inventory level at which action must be taken to replenish stock

8. Reorder quantity - the amount which should be ordered either at the end of a fixed time interval (periodic system) or when the reorder point is reached (perpetual system)

9. Holding costs - costs associated with having inventory on hand, also known as carrying costs

10. Ordering costs - costs incurred by placing an order for stock, also known as procurement costs

11. Stockout costs - costs associated with demand when inventory has been depleted

12. Total costs - the sum of all costs associated with inventories including holding, ordering, and stockout costs

CASE STUDY PROBLEM

You have recently been hired as the foodservice director of all commissary operations at Whiz Tech U, a local university. The supervisor of the stadium commissary reports to you that there is a recurring problem in ordering an adequate food inventory for this area. The demand for burger baskets varies considerably from week to week. The fans buy more burgers when their team is winning and less when the team is losing. This results in either stockouts of food supplies or large amounts of leftovers. The following facts have been reported to you by the supervisor of the stadium commissary:

1. Leadtime is 3 days

2. Ordering costs are $10.00 an order.

3. Holding (carrying) costs are $0.15 per unit per day.

4. Stockout costs are $5.00 per day.

5. A burger basket contains a 3-oz hamburger patty (cooked weight), sesame bun, 4 oz. french fries, and a 12 oz. carbonated soft drink.

CASE STUDY INVENTORY DATA

6.

Food Item	Servings per Issue Unit	Beg. Inv.	Reorder Point	Reorder Qty
Hamburger	40 patties/ 10 lb. case	90 cs	30 cs	80 cs
Buns	8 buns/ 8 bun pkg	300 pkg	150 pkg	350 pkg
Fries	16 4-oz svgs/ 4 lb. pkg	175 pkg	75 pkg	200 pkg
Fizzy Soda	10 12 oz svgs/1 gallon	320 gal	120 gal	320 gal

Demand/Issuing Information

Food Item	# of Baskets Demanded	# of Units to be Issued
Hamburger	300-320	8 cs
	321-360	9 cs
	361-388	10 cs
Buns	300-304	38 pkg
	305-312	39 pkg
	313-320	40 pkg
	321-328	41 pkg
	329-336	42 pkg
	337-344	43 pkg
	345-352	44 pkg
	353-360	45 pkg
	361-368	46 pkg
	369-376	47 pkg
	377-384	48 pkg
	385-388	49 pkg
Fries	300-315	20 pkg
	316-331	21 pkg
	332-347	22 pkg
	348-363	23 pkg
	364-379	24 pkg
	380-388	25 pkg
Fizzy Soda	300-309	31 gal
	310-319	32 gal
	320-329	33 gal
	330-339	34 gal
	340-349	35 gal
	350-359	36 gal
	360-369	37 gal
	370-379	38 gal
	380-388	39 gal

FOODSERVICE INVENTORY SIMULATION

The Main Menu

To start the foodservice inventory simulation, hold the floppy disk by the labeled end, label up, insert it into the disk drive, close the door on the disk drive adn turn the system on. The first thing that will appear on the computer monitor will be the copyright title followed by the program menu. It provides the user with three main program options including transaction activities that may be performed. Detailed description of the program options are on the pages following. The options are:

Option Number and Title	Operations Manual
1. Simulation of Perpetual Inventory	page 6, 7, 8
2. Simulation of Periodic Inventory	page 8
3. Economic Order Quantity (will not be used in FSM 442)	page 9
4. Quit the Program	page 9

To select an option, enter the number corresponding to the option of choice. Press "return". Begin by choosing option 1 and pressing the "return" key.

OPTION 1 - Simulation of Perpetual Inventory

1. This option allows the user to simulate a foodservice inventory containing four food items for 14 days using the perpetual inventory system.

2. Each day a new demand for burger baskets will be automatically generated printed on the screen.

3. You must decide how many units, if any, of each food item in the burger basket to issue from inventory to meet the day's demand. You may need to consult the chart on the preceding page to help you decide. Enter the amount to be issued and press return. You do not need to type in the words case or gal, etc.

   EXAMPLE: If the demand is 325 burger baskets, you would issue

hamburger patties	9	(cases)
hamburger buns	41	(pkg)
french fries	21	(pkg)
soft drink mix	33	(gal)

Hints on Correcting Typing Errors:
If a typing error has been made in entering data or you change your decision, and the "return" key has not been pressed, the key marked with an ⟵ will backspace the cursor.

After the "return" key has been pressed, corrections may be made by answering "N" (no) to the question, "Are these values correct?". You must then re-enter all the amounts to be issued including any corrections before going on to the next day.

4. At the end of each day in the perpetual inventory simulation you will see a mini-menu with five choices or options. Enter the number corresponding to the option of choice and press the return key. The choices will be as follows:
    1. Continue
    2. Print preceding days' inventory
    3. Place an order
    4. Print the final 14 days inventory
    5. Quit

5. Explanation of Mini-Menu.

Choice 1 to continue will allow you to go on to the next day in the simulation exercise.

Choice 2 to print the preceding days' inventory will allow you to get a printed list of transactions for each item for each day, up to but not including, the current day's transactions. The list will help you determine if you have reached a reorder point and need to place an order. The reorder quantity chart on the preceding page can help you decide how much to order.

Hint: Look at the beginning inventory and the reorder point before starting to see if you will need to place an order at the end of the first day. Remember, in the perpetual inventory system that order sizes are fixed, that is, the order quantity must be the same amount for the same food item, each time an order is placed. But you may order daily if you wish.

Choice 3 to place an order will allow you to enter the amount to be ordered for each food item and press return. You will not need to type in the words case or gal, etc.

EXAMPLE: After printing out the inventory record, you see that you have only 25 cases of hamburger patties on hand. This quantity is at or below the reorder point. You decide to order 80 cases, the recommended quantity. The other food items are well above their reorder points so you will not place a replenishment order this time. Your order list will look like this:

hamburger patties	80	(cases)
hamburger buns	0	(pkg)
french fries	0	(pkg)
soft drink mix	0	(gal)

It will take 3 days for an order to arrive. It will be automatically be added onto the current inventory. You will not be able to place emergency orders or fill backorders.

Hints on Correcting Typing Errors:
If a typing error has been made in entering data or you change your decision, and the "return" key has not been pressed, the key marked with an ←— will backspace the cursor.

After the "return" key has been pressed, corrections may be made by answering "N" (no) to the question, "Are these values correct?". You must then re-enter all the amounts to be ordered including any corrections before going on to the next day.

Choice 4 to print the final 14 days inventory will allow you to list the entire 14 days inventory transactions including all calculated costs at the end of the simulation.

Choice 5 quit will allow you to exit the simulation at the end of any day and return to the main menu. But you will lose all your simulation data unless you have finished the simulation and printed a final 14-day report.

OPTION 2 - Simulation of Periodic Inventory

7. Repeat steps 1 to 5 above to simulate the periodic (fixed period) inventory system for 14 days. Remember, that in the periodic inventory system, the order quantity for each food item may vary each time you place an order, as you build the inventory back to the beginning (par) level. But you will only be allowed to look at the inventory level and place an order once during each week. You will be able to place an order at the end of the fifth day and at the end of the tenth day of the simulation.

   EXAMPLE: After printing out the inventory record at the end of the fifth day, you see that you have only 35 cases of hamburger patties on hand. Though this is above the reorder point, you realize you will run out before the next opportunity to order, on the tenth day. So you decide to order at least 55 cases of hamburger patties to build the inventory back to the beginning level, 90 cases. You also decide to place orders for the other food items. Your order list will look like this:

hamburger patties	55	(cases)
hamburger buns	70	(pkg)
french fries	100	(pkg)
soft drink mix	240	(gal)

8. Compare the costs for both systems by looking at the 14 day printouts and filling in the study guide sheets.

OPTION 3 - Economic Order Quantity

This option will not be used in the FSM 442 class. The program designers are still working some "bugs" out of this option. Please skip this part and, either repeat options 1 and 2, or, use option 4 to exit the program.

OPTION 4 - Quit

When all the desired options have been completed, this option allows the user to exit the program.

APPENDIX B

Pretest

Posttest

Pretest

Soc. Sec. #____________________ Date____________________

PRE TEST FSM 442
Foodservice Procurement & Inventory Systems
Winter Term 1986

Read each question carefully and select the most appropriate response. Mark the selected answer on the Computer Answer Sheet. Please use only a No. 2 pencil for marking your answer.

1. What name is given to the inventory system in which orders for lettuce are placed every Tuesday for delivery on Friday but the number of cases ordered depends on the quantity used since the last delivery?

   a. perpetual
   b. mini-max
   c. periodic

2. A foodservice work-in-process inventory might include:

   a. flour, canned vegetables, eggs
   b. uncooked meatloaf, bread dough, cake batter
   c. ham sandwich, frosted cupcake, potato salad

3. Stock that is carried as a cushion to protect against forecast error is called:

   a. buffer inventory
   b. seasonal inventory
   c. fluctuation inventory

4. A physical inventory is:

   a. the same as a continual inventory
   b. economically impractical except in large facilities
   c. the determination of inventory quantity by actual count

5. A San Francisco restaurant keeps the following items in inventory. According to ABC analysis which items should be controlled most rigorously?

ITEM	COST	YR. DEMAND
Saffron	$ 55/oz.	5.25 lb.
Squash blossoms, fresh	$ 24/doz.	36 doz.
Goose liver	$ 75/lb.	32 lb.
Chanterelle mushrooms, fresh	$125/doz.	45 doz.
Lobster, live	$ 15/each	180 each
Pheasant breast, boneless	$ 4/each	288 each

   a. saffron
   b. saffron, mushrooms
   c. saffron, mushrooms, lobster

6. Stockouts are important in inventory control because it can cost a loss of:

   a. customer good will
   b. interest on capitol funds
   c. storage space costs

7. Advantages in utilizing the <u>fixed order period</u> (periodic) inventory system as compared to the <u>fixed order quantity</u> (perpetual) inventory system include:

   a. less personnel needed to maintain inventory records
   b. less buffer stock must be maintained in storage
   c. less chance of running out of stock during leadtime

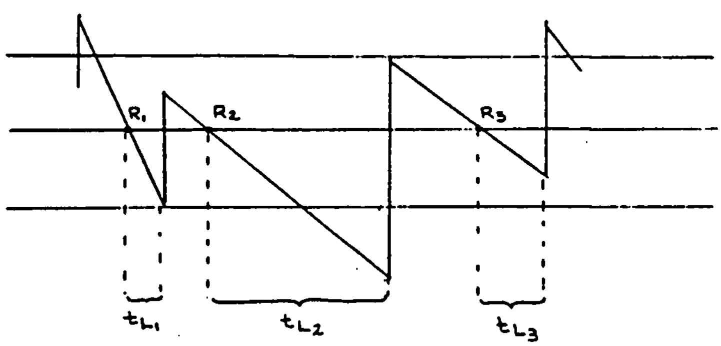
8. Why is it necessary for a foodservice facility to carry an inventory?

   a. to decrease carrying costs
   b. to decrease stockout costs
   c. to decrease labor costs

9. In a large hospital, cans of fruit juice are stored in the warehouse, kitchen storeroom, and the patient pantry refrigerator. This is an example of a:

   a. multistage inventory
   b. multiechelon inventory
   c. multilevel inventory

10. The graph below illustrates a:



   a. fixed order inventory system with constant demand and constant leadtime

   b. fixed period inventory system with constant demand and constant leadtime

   c. fixed period inventory system with variable demand and variable leadtime

11. Aunt Agatha's Cookie Company places an order for chocolate chips once a month. The chips are packed in ten 5 lb. packages per case. Normal usage is 250 lb. per week. Delivery is 5 days from the date an order is placed. If the baker finds 325 lb. on hand, anticipates normal use during the next four weeks, and wants 250 lb. minimum buffer stock at the end of the upcoming month, how many chips would be ordered?

    a. 925 lb. chocolate chips
    b. 950 lb. chocolate chips
    c. 1000 lb. chocolate chips

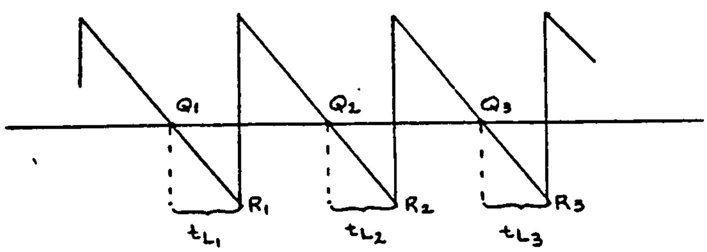
12. The problem above is an example of which type inventory system?

    a. fixed period inventory system
    b. fixed order quantity inventory system
    c. par level quantity inventory system

13. Procurement costs of items ordered include:

    a. sales taxes and transportation
    b. preparing specifications
    c. warehouse insurance against breakage

14. The graph below illustrates a:



    a. a fixed order inventory system with constant demand and a constant leadtime

    b. a fixed order inventory system with variable demand and variable leadtime

    c. a fixed period inventory system with variable demand and variable leadtime

15. Carrying costs may be determined by:

    a. summing the total purchase price of each item in inventory

    b. setting a fixed percentage of the average dollar value of inventory

    c. adding the costs of utilities, rent, and insurance, then dividing by 52 weeks

16. Disadvantages in utilizing the fixed order period (periodic) inventory system as compared to the fixed order quantity (perpetual) inventory system include:

    a. order size must be recalculated on a frequent basis
    b. higher costs of operating the record system
    c. less responsive to unexpected variations in demand

17. A foodservice manager should consider the following factors in determining when and how many cases of French champagne to order for a New Year's brunch menu.

    a. import quotas, ordering costs, delivery leadtime

    b. quantity price discounts, storage space, buffer stocks

    c. product availability, customer demand, current weather conditions

18. Optimal safety stock levels are determined by:

    a. procurement costs and stockout costs
    b. carrying costs and procurement costs
    c. carrying costs and stockout costs

19. Benefits in utilizing the fixed order quantity (perpetual) inventory system as compared to the fixed order period (periodic) inventory system include:

    a. lower costs associated with maintaining the record system

    b. buffer stocks needed only for the leadtime plus one order period

    c. high demand items require less management attention

20. Economic order quantities and order points should be evaluated annually for which class of foodservice inventory items under ABC analysis?

    a. class A items, such as porterhouse steaks
    b. class B items, such as frozen green beans
    c. class C items, such as dried herbs and spices

21. Accurate inventory records will result in:

    a. a reduction in personnel costs
    b. frequent physical inventories
    c. lower storage space costs

22. The <u>fixed order quantity</u> (perpetual) inventory system will be the most appropriate under which of the following conditions:

    a. demand fluctuations are great and difficult to predict
    b. the unit cost of the item is low
    c. possibility of stockouts is infrequent

23. Your head cook collects food supplies from inventory without completing a requistion. How would you solve this problem?

    a. control access to the storeroom
    b. switch to a fixed period inventory system
    c. implement a computerized record system

24. Food supplies should be ordered in the largest possible quantities because:

    a. it reduces carrying costs by maximizing use of storage space

    b. less frequent ordering reduces procurement costs

    c. it reduces the occurrence of stockout costs

25. Drawbacks in utilizing the <u>fixed order quantity</u> (perpetual) inventory system as compared to the <u>fixed order period</u> (periodic) inventory system include:

    a. requires computer assistance to maintain inventory records

    b. low demand items receive less management attention

    c. higher procurement costs resulting from more frequent orders

26. Utilization of computerized food inventory records can:

    a. provide immediate information on food item status
    b. eliminate the need to take physical inventory
    c. pinpoint the extent of undocumented food issues

27. Calculation of total monthly inventory turnover will indicate:

    a. how often food has been ordered and used
    b. low demand inventory food items
    c. the order size that minimizes total inventory costs

28. The <u>fixed order period</u> (periodic) inventory system will be the most appropriate under which of the following conditions:

a. there are many issues of small quantities from inventory
b. a large number of items are ordered from several sources
c. carrying costs are high

Posttest

Soc. Sec. # ______________________ Date ____________

POST TEST FSM 442
Foodservice Procurement & Inventory Systems
Winter Term 1986

Read each question carefully and select the most appropriate response. Mark the selected answer on the Computer Answer Sheet. Please use only a No. 2 pencil for marking your answer.

1. Accurate inventory records will result in:

   a. a reduction in personnel costs
   b. frequent physical inventories
   c. lower storage space costs

2. Carrying costs may be determined by:

   a. summing the total purchase price of each item in inventory

   b. setting a fixed percentage of the average dollar value of inventory

   c. adding the costs of utilities, rent, and insurance, then dividing by 52 weeks

3. Stock that is carried as a cushion to protect against forecast error is called:

   a. buffer inventory
   b. seasonal inventory
   c. fluctuation inventory

4. Economic order quantities and order points should be evaluated annually for which class of foodservice inventory items under ABC analysis?

   a. class A items, such as porterhouse steaks
   b. class B items, such as frozen green beans
   c. class C items, such as dried herbs and spices

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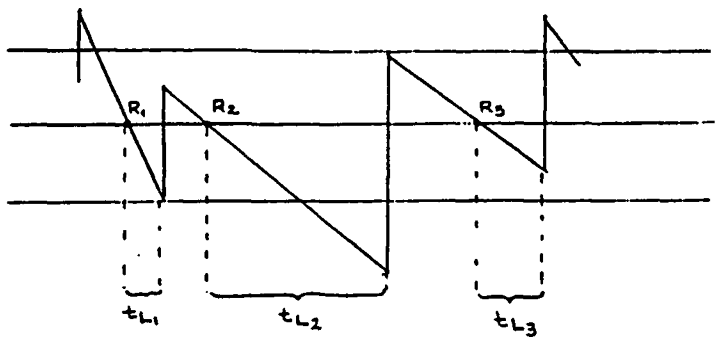

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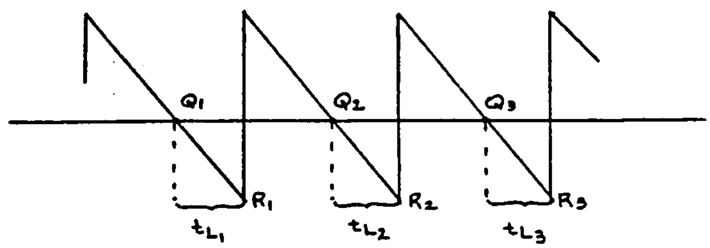

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    b. the unit cost of the item is low
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    a. sales taxes and transportation
    b. preparing specifications
    c. warehouse insurance against breakage

APPENDIX C

Student Information Sheet

Student Evaluation of Inventory Lecture/Simulation

Student Information Sheet

Soc. Sec. #________________________ Date ______________

STUDENT INFORMATION SHEET

Read each question carefully and select the most appropriate response. Mark the selected answer on the Computer Answer Sheet. Please use only a No. 2 pencil for marking your answer. You may write in answers on this Student Information Sheet for questions 4. and 12.

1. What is your age group?

   a. 19-22 yrs b. 23-30 yrs c. 31-40 yrs d. 41-50 yrs e. 51 yrs +

2. What is your sex?

   a. Female b. Male

3. What is your class level?

   a. Senior b. Post-bac c. Graduate d. Special

4. What is your major?

   a. Dietetics b. HRTM Mgtmt. c. Food Systems Mgtmt. d. Health Care Admin. e. Other

   If other major, write in here

****

HAVE YOU STUDIED ANY ACADEMIC COURSE WHICH INCLUDED ANY OF THE FOLLOWING:

5. Forecasting techniques? a. Yes b. No

6. Perpetual inventory? a. Yes b. No

7. Periodic inventory? a. Yes b. No

8. Physical inventory? a. Yes b. No

9. Fixed order period theory? a. Yes b. No

10. Fixed order quantity theory? a. Yes b. No

11. Computer programming? a. Yes b. No

****

12. Have you had any foodservice-related work experience?

    a. Yes b. No

    If yes, what was/were your position title(s)?

    ____

    How long did you hold the position(s) named above?

    ____

HAVE YOU PERFORMED ANY OF THESE TASKS ON THE JOB(S) NAMED ABOVE?

13. Ordering? a. Yes b. No

14. Receiving? a. Yes b. No

15. Storing? a. Yes b. No

16. Issuing? a. Yes b. No

HAVE YOU EVER USED A COMPUTER TO DO THE FOLLOWING FOODSERVICE RELATED TASKS?

17. Ordering? a. Yes b. No

18. Receiving? a. Yes b. No

19. Issuing? a. Yes b. No

Student Evaluation of Inventory Lecture/Simulation

Soc. Sec. #____________________________ Date________________

STUDENT EVALUATION OF INVENTORY LECTURE/SIMULATION

Read each question carefully and select the most appropriate response. Mark the selected answer on the computer sheet. Please use only a No. 2 pencil for marking your answer.

1. I have completed the microcomputer inventory simulation program and study guide assignment.

   a. Yes b. No

2. How much time did you spend at the microcomputer using the inventory simulation program?

   a. one hour or less b. two hours c. three hours d. four hours e. five hours or more

3. How much time did you spend completing the two study guide assignments?

   a. one hour or less b. two hours c. three hours d. four hours e. five hours or more

****

From the five phrases below, select the one which most closely expresses your feeling about this entire learning experience. Mark the letter on your Computer Answer Sheet. Please mark only one response for each statement numbered 4 through 13.

a. strongly agree b. agree c. undecided d. disagree e. strongly disagree

4. The computer is an important part of learning to manage food-service inventories. a b c d e

5. My workload for this course was greatly increased by including the microcomputer simulation exercise. a b c d e

6. The concepts I learned using the microcomputer materials made me more interested in inventory management. a b c d e

7. I was apprehensive of the technical difficulties in using the microcomputer. a b c d e

8. When I enroll in another food systems management course I would prefer that computer materials be included. a b c d e

9. Learning how to use the microcomputer distracted from the study of foodservice inventory management. a b c d e

10. From taking this course I would like to know more about how computers may be used in other areas of food systems management. a b c d e

11. Computer instruction is just another step toward depersonalized instruction. a b c d e

12. I found using the microcomputer in this course to be an inefficient use of my time. a b c d e

13. I feel the microcomputer materials were a valuable addition to this course. a b c d e

****

Please answer the following questions either yes or no. Mark the selected response on the Computer Answer Sheet.

a. Yes b. No

14. The pre/post tests instructions and questions were written in clear terms that were easily understood. a b

15. The pre/post test questions increased my understanding of inventory management concepts. a b

16. The pre/post tests were adequate in covering the topic of computer-assissted inventory management. a b

17. The simulation operations manual was written in clear terms that were easily understood. a b

18. The simulation operations manual was well organized. a b

19. The simulation operations manual was adequate in explaining how to correct input errors and prevent the program from stopping during use. a b

20. The microcomputer inventory simulation program was easy to use. a b

21. The microcomputer inventory simulation program was easily understood. a b

22. The microcomputer inventory simulation program added to my understanding of inventory management. a b

23. The microcomputer inventory simulation program was boring. a b

24. The microcomputer inventory simulation program would be a good way to provide inventory management experience to students when actual on-the-job experience is not practical or available. a b

25. The microcomputer inventory simulation program did not take too much time to use. a b

26. The study guide instructions were written in clear terms that were easily understood. a b

27. The study guide assignment was well organized. a b

28. The study guide assignment enhanced my understanding of the microcomputer imventory simulation program. a b

29. The study guide assignment did not take too much time to complete. a b

Additional Comments: ____

____

____

____

____

APPENDIX D

Table 4: Pretest, Posttest Scores and Changes in Scores for the Participants in the Experimental and Control Groups

Table 6

PRESTEST, POSTTEST SCORES AND CHANGES IN SCORES FOR THE PARTICIPANTS IN THE EXPERIMENTAL AND CONTROL GROUPS (MAXIMUM SCORE, 28 POINTS)

Experimental (n = 34)				Control (n = 34)			
Participant	Pretest Score	Posttest Score	Change in Score	Participant	Pretest Score	Posttest Score	Change in Score
1.	19	21	+2	35.	16	22	+6
2.	18	18	0	36.	20‖	20	0
3.	13	16	+3	37.	16	16	0
4.	14	18	+4	38.	13	12**	-1
5.	15	14	-1	39.	12	15	+3
6.	10*	15	+5	40.	16	20	+4
7.	17	18	+1	41.	14	19	+5
8.	19†	19	0	42.	14	16	+2
9.	15	21	+6	43.	11	18	+7
10.	13	17	+4	44.	16	16	0
11.	13	17	+4	45.	15	14	-1
12.	13	20	+7	46.	18	13	-5
13.	16	17	+1	47.	18	23††	+5
14.	14	14	0	48.	17	19	+2
15.	17	20	+3	49.	16	18	+2
16.	17	17	0	50.	10¶	13	+3
17.	18	18	0	51.	13	13	0
18.	17	18	+1	52.	14	14	0
19.	16	23#	+7	53.	17	21	+4
20.	16	20	+4	54.	17	19	+2
21.	12	21	+9	55.	19	16	-3
22.	11	14	+3	56.	14	14	0
23.	16	19	+3	57.	17	18	+1
24.	15	15	0	58.	15	14	-1
25.	15	23	+8	59.	18	17	-1
26.	11	20	+9	60.	12	13	+2
27.	14	18	+4	61.	14	18	+4
28.	16	21	+5	62.	12	18	+6
29.	15	17	+2	63.	16	19	+3
30.	14	19	+5	64.	13	14	+1
31.	18	17	-1	65.	14	19	+5
32.	16	20	+4	66.	16	21	+5
33.	18	19	+1	67.	14	18	+4
34.	16	13‡	-3	68.	15	18	+3

* experimental pretest low score
† experimental pretest high score
‡ experimental posttest low score
# experimental posttest high score
¶ control pretest low score
‖ control pretest high score
** control posttest low score
†† control posttest high score