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Elemental Times for Estimating Clinical Instructor Demand in a Coordinated Dietetic Program

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To the Graduate Council:

I am submitting herewith a dissertation written by Erskine Ray Smith entitled "Elemental Times for Estimating Clinical Instructor Demand in a Coordinated Dietetic Program." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

Betty L. Beach, Major Professor

We have read this dissertation and recommend its acceptance:

Kenneth E. Kirby, Mary J. Hitchcock, Roy E. Beauchene

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Vice Chancellor
Graduate Studies and Research

ELEMENTAL TIMES FOR ESTIMATING CLINICAL INSTRUCTOR DEMAND IN A COORDINATED DIETETIC PROGRAM

A Dissertation

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Degree

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Erskine Ray Smith

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ABSTRACT

During the initial phase of clinical training, dietetic students require close supervision. Low faculty/student ratios have been used to achieve adequate supervision. Academic administrators have expressed concern about increased faculty demands associated with coordinated programs as such programs do not conform to the traditional formula used to fund academic units. The purpose of this research was to develop a methodology for estimating time demands of clinical instructors using different instructional strategies and to study the effects of the strategy mixes on total clinical instructor time in relation to class size and competency level students could achieve. Clinical instructor elemental times were estimated as part of a framework to establish, validate, and test a quantitative data base for a coordinated undergraduate program in dietetics. Elemental times were classified as fixed or variable. Fixed elements were those teaching activities in which class size had no effect on instructor time. Time demand for variable elements were based on per student or ratio demand. Per student variables tended to have a stronger effect on total clinical instructor time required for a clinical unit when the size of the class increased than did ratio variables. Elemental times were applied to sixty-four instructional strategy mixes, identified from questionnaires completed by panels of clinical instructors, students, and clinical facility personnel. Competency contribution for each mix was rated on a five point scale by clinical instructors. Competency rating and demand on instructor time were input for two schemes, Clinical Instructor Decision Model

(CIDMO) and the Heuristic Routine for Selecting Instructional Strategy Mixes (HRSISM), designed to optimize use of instructor time while maximizing competency rating. CIDMO and HRSISM solutions obtained for four class sizes, ten, fifteen, twenty, and twenty-five students, had higher competency ratings than mixes currently used. Elemental times and competency contribution ratings were instrumental in selecting instructional strategy mixes. Further research designed to study the use and effectiveness of clinical instructor time was suggested. Research should be undertaken to study the effectiveness of various combinations of instructional strategies.

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CHAPTER I

INTRODUCTION

Technological advances, research findings, and supporting resources during the past decade have combined to force a different kind of health delivery system (Lewis and Beaudette, 1977). More emphasis is being given to preventative health care and particularly to the importance of nutrition. As a result, the role of the practicing dietitian has become more prominent on the health care team and has increased the demand for dietitians.

As early as the late 1960's the profession was aware that insufficient numbers of entry-level dietitians were being educated to meet the forecasted increase in demand (Wilson, 1972; Sharp, 1973; Pennell and Hoover, 1970). A comprehensive study by the profession resulted in the recommendation that better use be made of the 1,500 dietitians employed in the education of dietitians so that the profession could more ably cope with future demands. The development of coordinated undergraduate programs in dietetics, patterned after the Ohio State University's program, was recommended (Study Comm. on Dietetics, 1972). As of December 1981, there were 70 accredited coordinated undergraduate programs in dietetics located in major universities and colleges (The Am. Dietet. A., 1982).

A coordinated undergraduate program (CUP) incorporates required clinical experiences into a four year curriculum leading to a bachelor's of science degree and thus has reduced the time required

to become eligible to write the registration examination. While students have had a decreased demand on their resources when enrolled in a coordinated program, the academic institutions have had an increased demand on faculty due to the incorporation of clinical experience. A coordinated program is divided into two phases. The pre-professional phase is the first two years of the four year curriculum. The last two years make up the professional phase. To be accredited, a program must offer clinical experiences concurrent with didactic study (The Am. Dietet. A., 1976). This increased faculty demand has caused considerable concern on the part of academic administrators as staffing for the program is more closely related to other clinically oriented health professional program than the traditional formula funded academic units.

I. IDENTIFICATION OF THE PROBLEM

For accreditation, minimum staffing requirements of one full-time equivalent instructor to ten students must be met. Based on experience, CUP's have found a low faculty-student ratio is essential in that each dietetic student has direct contact in the planning, preparation and service of patient meals as well as direct patient dietary education.

The dietetic student in the clinical facility in the junior phase of CUP requires close supervision, a 1:1 to 1:5 ratio of faculty to student to provide required student training. The ratio gradually increases over the two years to 1:8 to 1:10 faculty to students. Justification for this close supervision is to assure

high quality care for patients during the initial training period of the dietetic student. A long range goal of the coordinated program at The University of Tennessee, Knoxville has been to find a satisfactory means of increasing the ratio during the initial phases of the program while maintaining the desired level of instruction.

Two major factors are presently considered when determining the number of students to participate concurrently in a clinical experience. These factors are classified as facility related determinants and faculty related determinants. Facility related determinants are: (1) the amount of facility personnel time that can be devoted to participation in the dietetic program; (2) the number of qualified staff members to assist in supervision of students; (3) the availability of appropriate or desired clinical experiences; and (4) the availability of space for students to work. The one faculty related determinant is the availability of clinical instructor time for performance of direct teaching activities as related to a specific experience unit.

Since the number of students accepted for an experience is related to the time demands for clinical instructors and facility personnel, the instructional strategy mix selected for an experience unit could influence the number of students provided the experience. The instructional strategy mix selected will influence the degree of supervision required and the level of competence attained by students.

Coordination between didactic and clinical courses in CUP's has been achieved by various instructional strategies and techniques.

Videotaped simulation and computer assisted instruction (CAI) have been used successfully to replace actual experiences not available due to the number of students requiring an experience, time conflicts, limited number of available experiences in a clinical facility, the confidentiality of the situation, scheduling difficulties that make it impossible for students to be present in the facility when desirable experiences are present, or for legal and moral considerations (Canter and Beach, 1981; Fiedler and Beach, 1979; Breese, et al., 1977; Jackson, 1978).

Videotaped simulation has successfully replaced actual employee counseling. Such opportunities were limited due to legal concerns of the facilities; and, due to scheduling, the student being unavailable to counsel employees in a timely manner (Fiedler and Beach, 1979). Computer assisted instruction was used to provide decision making experiences related to personnel such as promotion of a foodservice worker to a supervisory position, deciding on an approach for an employee training program, and hiring a new employee (Canter and Beach, 1981).

In some patient related situations, clinical facilities may not have enough desired learning experiences for students to adequately practice and develop needed competencies. In such situations CAI has been used to allow students to practice soliciting information from patients, interpreting patient responses and identifying sociocultural characteristics of patients in order to prepare students for acutal patient encounters (Breese, et al., 1977; Jackson, 1978). Use of CAI and other self-paced instructional techniques as substitutes

for actual experiences by CUP's may reduce demand on faculty time and alleviate concerns of administrators over the costs of clinically oriented programs.

II. PURPOSE OF THE STUDY

The purpose of this study was to develop a methodology for estimating time demands of clinical instructors using different instructional strategies and to study the effects of instructional strategy mixes on total clinical instructor time in relation to class size and competency level students could achieve.

CHAPTER II

REVIEW OF LITERATURE

Traditionally, nonclassroom based learning has been used to provide professional level experiences for students pursuing careers in the teaching, psychological and social sciences, and in the health care professions (Altman, et al., 1978). No longer is field experience an adjunct to the traditional classroom model, nor an alternative, but has become an integral part of educational models in which interplay between field and classroom experience is the core. Field experience resulted in an increased receptiveness by students of the materials presented in the classroom, development of student autonomy beyond the student role, an increased ability of students to approach problems from the point of view of others, and an increased ability to think about multiple factors and their relative importance (Hursh and Borzak, 1979). Coordination of practice and classroom learning is a process that directly and simultaneously relates instruction and experiences (Lewis, 1975). A coordinated program in dietetics is characterized by interrelated studies in the classroom and in the clinical environment which allows students to demonstrate mastery of a set of essential competencies needed for entry-level practitioners (Hart, 1974; Lewis and Beaudette, 1977).

I. COMPETENCY BASED EDUCATION

Competency based education (CBE) is an instructional system in which students are given credit for performing specified

competencies at a predetermined level of proficiency (Ainsworth, 1977). Competency based education was first used for teacher education. Since the introduction of competency based teacher education (CBTE) or performance based teacher education (PBTE), which it is sometimes called, CBE has been used in the education of several groups of professionals, including dietitians (Rinkle, 1980). The American Dietetic Association in 1972 adopted a policy that required academic requirements for membership be expressed in terms of basic competencies and areas of knowledge rather than traditional courses and credit hours (Study Comm. on Dietetics, 1972).

Educational programs that are established to meet a set of competencies allow more flexibility in curriculum planning than traditional course listings (Houston and Warner, 1977; Hart, 1976). During the planning process, the set of competencies are organized so that instruction is designed to meet a set of objectives that contribute to one or more of the competencies. The competencies and their enabling objectives are usually identified by practitioners of the profession and form the basis for educational programs for future practitioners (Bell, 1978; Shanklin and Beach, 1980). Recognizing that perceptions of practitioners may be limited by their educational and work experiences (Houston and Warner, 1977), The American Dietetic Association has placed a high priority on developing more effective means of identifying competencies needed by entry-level practitioners (Loyd and Vaden, 1977).

Because of the attention placed on required and optimal behaviors of the learner as well as the performance and consequence of

the behaviors, competency based dietetic education programs emphasize goal orientation and focus on individual attainment of objectives through personalization of instruction (Houston and Warner, 1977; Bell, 1976; Hart, 1976). The need for personalization was evidenced by findings reported by Loyd and Vaden (1977) in their study to evaluate essentiality of entry-level competencies. Practitioners indicated that those competencies most desirable for the entry-level generalist dietitian should be performed with little or no supervision. Therefore, persons accepting entry-level positions must be able to effectively perform the competency before leaving the educational program.

One difference between competency based programs and traditional educational processes is that students are held responsible for achieving clearly delineated outcomes (Knott, 1975). Competency based programs allow more opportunities for field experiences and dietetic students in such programs are exposed to a number of essential competencies of entry-level dietitians on the assumption that if a student performs the competencies at acceptable levels of proficiency, the student is ready to practice dietetics (Johnson, 1974; Hahn and Meinke, 1978; Hart, 1976).

Competency based programs operate under a philosophy of mastery learning. Proponents of mastery learning assume that all students can and will learn most of what they are taught when objectives are clearly defined and instruction is orderly and at a level understandable by the student. Students should be given timely feedback on performance and should be given sufficient time to achieve

mastery (Spaddy, 1977; Hahn and Meinke, 1978; Bloom, 1974). Student related factors that contribute to mastery are the amount of time devoted to learning the material, inductive and deductive skills, and comprehension of the learning situation. The instructor can contribute to mastery by effectively organizing and presenting instruction (Block, 1971). Self-paced or group-paced mastery learning strategies assume that all students must achieve the minimal level of acceptable performance for each segment of expected learning outcomes before the learning process is completed (Block, 1979).

Self-Paced Individualized Instruction

Since the introduction of the Keller plan of instruction the personalized system of instruction (PSI) has been evaluated in several professions (Hursh, 1976). Students and teachers must recognize that their roles are altered when instruction is self-paced and individualized. Students become active, rather than passive in the learning process and accept more responsibility for their learning since learning is controlled by the learner. Instructors are required to clearly define objectives, divide course material into small lesson units, and provide feedback (Cross, 1976). The use of lecture as the vehicle for information transfer is reduced in courses taught by the PSI approach (Weissman and Shapiro, 1973).

Hursh (1976) concluded from a review of the literature that PSI tended to produce small, but reliable performance advantages over traditionally taught courses. A study of literature findings by Kulik and co-workers (1979) showed that PSI courses tended to

increase final examination scores by nine percent. A fourteen percent increase was found when achievement tests were given several months after the conclusion of a course. Students that have taken PSI courses tend to perform better in other courses than students not having a PSI course (Moo Cohen and Lansen, 1976). Students rated PSI courses as more challenging, more enjoyable, and higher in overall quality than traditionally taught courses (Kulik, et al., 1979). Increased achievement levels and lower attrition rates were attributed to the use of mastery learning strategies employing the PSI concepts for a battery of courses taught in urban junior colleges (Guskey and Mansaas, 1979).

Extensive use of self-paced instructional programs for educating health professionals was found in the literature. Comparisons of the effectiveness of PSI courses and conventional means of teaching professionals have shown that PSI was at least as effective as traditional approaches (Bogner, et al., 1975; Weissman and Shapiro, 1973; Kahn, et al., 1973; Suess, 1973; White, et al., 1973). Students that have taken PSI courses received higher scores on the National Board of Medical Examiners examination than those students not having such a course (Stritter, et al., 1973).

The self-paced concept has been effective for teaching didactic and clinical concepts to dietetic students (Roach and Wakefield, 1974; Miller and Spears, 1974; Bates and Spears, 1978). Post-test scores for dietetic students completing a self-paced course in quantity food purchasing were 20 percent higher than pre-test scores but did not

differ significantly from those of students completing a traditionally taught course (Pretrzyk, et al., 1978). No significant difference was found for final test scores of students enrolled in a nutrition-lecture-laboratory course taught via the conventional method and a self-paced approach (Boren and Foree, 1977). Likewise, no significant difference was found between student performance of patient interviewing skills taught via the traditional method and a self-paced approach (Bates and Spears, 1978). Respondents to a questionnaire by Sifferman and Hoover (1981) indicated that the use of the in-basket approach which makes use of simulation was an adequate means to teach food-service management skills for a computerized management system. Computer simulated management experiences were reported as an effective means of teaching dietetic students decision making skills (Dow, 1981). Patient simulators were interviewed by dietetic students as their initial experience for soliciting information from patients. This instructional strategy was rated as effective for teaching patient interviewing skills (Sutnick and Carroll, 1981).

Computer managed instruction was used as a means of reducing demands on clinical instructor time for a dietetic education program. Three types of system outputs were computer generated which clinical instructors would normally compile: transaction reports of student performances; student progress reports; and, an end of the course report. The end of course report summarized student performance, clinical units attempted, and clinical units satisfactorily completed. Students and clinical instructors evaluated the program as effective

because of the two major benefits, reduced clinical instructor time and the constant feedback to students (Argo, et al., 1981).

<u>Clinical Instructor</u>

The teaching that takes place in the clinical setting such as small group discussions or individual conferences is a vital component of medical or allied health education (Stritter, et al., 1975). Direct supervision by a clinical instructor is required for many clinical experiences. Clinical instructors, as experienced practitioners facilitate student learning by providing guidance, supervision, and evaluation of experiences that allow students to practice a variety of skills and abilities. An effective clinical instructor sets objectives and teaches for comprehension rather than recall (Stritter, et al., 1975; Reddout, 1973; Rzonca, 1976).

The role model in the clinical setting has an effect on the competence of the students and influences the level of professionalism of the students as dietetic practitioners. Graduates of dietetic programs should be exposed to those practitioners that exhibit the highest levels of professionalism (Watson, 1976).

The clinical instructor to student ratio is one factor that influences the quality of clinical experiences. The American Dietetic Association (1976) recommends that there be at least one full-time faculty equivalent per ten students enrolled in the professional phase of CUP's. The number of students per instructor varies. A range of twelve to twenty students was recommended by Hyman (1974) as optimal for discussion groups. Discussion groups of less than twelve

participants may limit the scope of the discussion to only a few viewpoints, especially when the group members have had similar experiences. Class sizes larger than twenty may stimulate lecture and limit group discussion. Optimum class sizes are influenced by the topic, group members' knowledge of the subject, students' ability to reason, instructor's leadership skills, interest of the class, and diversity of beliefs and preparation.

The number of students to admit to a self-paced course is a function of how many instructors are needed as facilitators to monitor student progress at an instructional station and the number of instructional stations. Instructor to student ratio and staffing requirements are affected by the instructor's facilitating ability, competence in skills being taught, and service to other courses. As a facilitator, the instructor must not only be knowledgeable and able to transfer this knowledge to students, but must have skills as an advisor, administrator, evaluator, counselor, and tutor. These skills may not be required to the same degree in traditional educational systems (Caffarella, et al., 1980).

Several factors related to the instructional setting affect instructor to student ratio or overall staffing needs for a course. These factors are related to personal safety, type and cost of equipment, explanation of operating procedures, and the quality of the course material. Clinical facilities provide a location for learning experiences that lead to the desired outcomes. Like any site in which learning is to occur, clinical facilities must possess an environment

suitable for learning appropriate competencies, skills, and attitudes. Personnel in the clinical facilities must be interested in and qualified for working with students at the level desired (Pascasio, 1976). For an accredited CUP, students must be supervised by a registered dietitian (The Am. Dietet. A., 1977).

II. LINEAR PROGRAMMING

Linear programming is a technique for allocating scarce resources among competing alternatives according to some criteria to be optimized (Paranka, 1975). The term linear programming has been used to define the process that involves the planning of activities to obtain an optimal solution from all feasible solutions for problems in which the decision variables are nonnegative, have an objective function, and a set of constraints (Hillier and Lieberman, 1974; Phillips, et al., 1976; Buffa and Dyer, 1977). The technique using the simplex method has evolved as a tool for solving resource allocation problems and as an aid to decision making in the health care, petroleum, education, food processing, and foodservice industries (Buffa and Dyer, 1977; Beach, 1974).

In order for a situation to be studied via a linear programming model, it must meet four requirements: variables and resource demands must be linearly related; must possess an objective function; resources must be additive; and variables must be nonnegative. To be linearly related the demand on resources must increase as the amount of the variables produced are increased. The variables must

possess an attribute that is optimized by the objective function. Optimization of an attribute may be either maximized or minimized. Attributes that are usually maximized are profit or saving related, whereas costs are usually minimized. The demand on each resource required for production of variables must be added. If two of the variables require time on the same machine during production, the amount of time that the machine was used should be equal to the amount of time required for the levels of the variables produced. Since it is not feasible to have negative amounts of available labor or level of production, variables must be either zero or positive (Dantzig, 1963; Hughes and Grawoig, 1973).

Linear Programming in Education

The use of management techniques in the education arena is becoming increasingly more popular for allocating limited resources and controlling costs (Balinsky, 1976; Shih and Sullivan, 1977; Franz, et al., 1981). University administrators must continuously make decisions as how best to allocate educational resources to achieve institutional objectives (Wehrung, et al., 1978; Joiner, 1980; Kendall and Luebbe, 1981; Wright and Lawless, 1981). Traditionally, university administrators have been faced with allocation problems for increasing demands for resources, but today's problems for many institutions involve allocation of resources on a steady-state basis or allocation of fewer resources for decreasing numbers of students (Gaithers, et al., 1981; Karber and MacPhee, 1981). In fact many

institutions of higher learning are faced today with problems associated with costs increasing faster than revenue (Wehrung, et al., 1978).

Linear programming models have been used by numerous individuals to study resource allocation problems in education. Early attempts to apply linear programming in decision making in higher education lead Andrew and Collins (1971) to conclude that use of linear programming was too time consuming and too costly to be of real benefit. Cost simulation models were considered too costly to be of benefit to education administrators (Hopkins, 1971). In fact McNamara (1971) suggested that if mathematical programming models were to be used successfully by education administrators their use should be limited to specific problem areas and that the application be on small problems. Mathematical models have been used successfully in higher education administration as a decision making tool for educational problems in which optimization takes place in well defined micromodels of a system (Stimson and Thompson, 1974; Tillett, 1975; Breslow, 1976; Bloomfield and Updegrove, 1981).

Some uses of linear programming and its extension, goal programming, has included such activities as determining faculty needs, matching faculty to courses, minimizing costs, and budgeting (Walters, et al., 1976). Goal programming models are linear models with multiple objective functions and allow the user to make evaluations of marginal tradeoffs between possible courses of action and the cost of various goals which are considered as constraints (Ignizio,

1976; Gleason and Lilly, 1977; Kornbluth, 1973; Lee and Moore, 1974). Prototype models simulating situations in which decisions were made regarding future budgetary needs were developed with solutions generated by linear or goal programming (Walters, et al., 1976; Wehrung, et al., 1978; Joiner, 1980; Gray, 1980; Averill and Suttle, 1975).

Linear programming has been used as an effective tool to aid in faculty staffing decisions. The objective function for such studies was to assign instructors to courses so that the sum of instructors' preferences for courses would be maximized. Four of seven departments improved their sum of preference ratings via linear programming over the traditional assignment method (Tillett, 1975). In addition to assigning instructors to courses, a time schedule for when to offer each course was developed that would limit the number of courses that an instructor would teach in a term and in an academic year (Shih and Sullivan, 1977).

In another type of scheduling problem, linear programming was used to determine schedules for students enrolled in a set of courses that used individualized learning strategies. The objective function of that study was to minimize delays in completing a course caused by lack of an adequate number of computer terminals for computer assisted instruction, or other limited resources required for use of individual learning strategies when a large number of students were enrolled in the set of courses. The model proved effective in reducing delay time for completion of the set of courses (Ruefli, et al., 1978).

In another student scheduling problem, linear programming with a branch and bound algorithm was used to minimize the number of days that students were scheduled to write more than one examination during finals week (Anderson and Bernhard, 1981).

Knapsack Problems

The simplex algorithm for solving linear programming problems is an efficient method except for special cases in which one or more of the variables are integer constrained (Salkin and Balinsky, 1973). When solutions for linear programming problems must have integers in the solution, rounding off simplex solutions may be acceptable for some types of problems (Dantzig, 1957). But in special cases such as when one must choose between several alternatives or policies rounding off may not give solutions that approximate optimal. Researchers have been engaged in trying to develop algorithms for integer problems (Salkin and de Kuyver, 1975).

The knapsack problem is one type of integer linear programming problem. Knapsack problems are found in situations in which the problem is to choose the best set of alternatives from an available list subject to limited resources. Knapsack problems may be single constrained or have several constraints. The latter is called multiple choice constrained knapsack problems (Shih, 1979). A knapsack problem may be described as a problem to find the most desirable set of objects or articles that a hiker should pack in a knapsack given a measure of desirability, the weight of the objects, and the maximum weight capacity of the knapsack (Dantzig, 1957). This type of

problem may be expressed mathematically, if $x_j=1$ the jth item is selected and if $x_j=0$ it is not selected. The following expressions represent this type of problem:

$$(1)\ \text{maximize } Z = \sum_{j=1}^{j=n} b_j x_j$$

$$(2)\ \text{subject to: } \sum_{j=1}^{j=n} a_j x_j \leq P$$

$$x_j = 0 \text{ or } 1$$

(Dantzig, 1957)

Where:

b_j = measure of desirability for the jth item

a_j = weight of the jth object or article

P = capacity weight of the knapsack

j=1 to n the number of objects or articles

Expressions (1) and (2) state that the items selected by the hiker will maximize total desirability while satisfying the constraint on total weight (Salkin and de Kuyver, 1975).

Extensive reports of the development of algorithms for knapsack or "zero-one" linear programming problems were found in the literature (Greenberg and Hedgerich, 1970; Nauss, 1976; Loulou and Michaelides, 1979; Shih, 1979; Sinha and Zolters, 1979; Zemel, 1980). Business and industrial applications of knapsack problems, often called "zero-one" are very extensive. Examples include cargo loading, cutting stock problems, facility location problems, resource task scheduling, policy determination, capital budgeting, menu planning, and selection

of library journals (Salkin and Balinsky, 1973; Salkin and de Kuyver, 1975; Shih, 1979; Glover and Klingman, 1971).

III. ESTIMATING TIME USING THE EXECUTIVE APPROACH

Time estimates based on practitioners' recollection of past experiences is one way to establish time standards (Krick, 1962). The executive approach is a technique that makes use of a small number of individuals, knowledgeable about the situations of interest, to make group decisions about specific attributes of the situation. Time estimates when made by experienced estimators can result in relatively accurate times for critical path scheduling (O'Brien, 1971; Moder and Phillips, 1970). Expert panels have been used to determine elemental times required to produce menu items for a quantity food service and to develop an algorithm for production scheduling in various food production facilities. The executive approach was chosen because of the speed in which elemental times could be generated and analyzed (Beach, 1974; Goodwin, 1976; Lambert and Beach, 1980; Antrobus, 1981).

IV. NOMINAL GROUP PROCESS

The nominal group process is a structured technique designed to obtain qualitative information from group members closely associated with the problem or situation and to facilitate group decision making (Delbecq, et al., 1975). Nominal groups consistently generated more ideas than interacting groups and group members were more receptive to sharing ideas in nominal groups than interacting groups which tend to

inhibit individual judgement (Delbecq and Van de Ven, 1971; Graham and Dillion, 1974; Nemiroff, et al., 1976; Huber and Delbecq, 1972). Some shortcomings of an interacting group were that the number of ideas generated was limited to usually one, participants were not as involved in the brainstorming process because they worried about what others thought of their ideas, some well known or highly thought of individuals tended to dominate the group, and interacting groups needed time to maintain interpersonal relationships (Vroman, 1975).

Proponents of the nominal group process have suggested that the following procedure be used: (1) group members respond individually and silently to a task or problem presented by the group leader; (2) after the silent period, ideas are recorded in round robin fashion for members to see; (3) after all ideas are recorded, discussion is allowed; and (4) the meeting concludes with silent, independent voting (Delbecq, et al., 1975). A major university in a study of the quality of instruction at the institution used the nominal approach to increase faculty participation (Kohler and Pangallo, 1972). The nominal group process was used to identify elements within a clinical facility that were supportive for clinical experiences for CUP's and for a self-study of CUP (Sowell, 1979; Rhoades, et al., 1981).

Literature findings for both the nominal group process and linear programming have shown that the techniques were effectively used in the area of educational administration. Coupled with the executive approach which has been shown to be an efficient method for estimating elemental times, the combined usage of knapsack linear

programming and the nominal group process should be useful for persons responsible for making decisions in CUP's for more efficient use of limited clinical instructor time.

CHAPTER III

DEVELOPMENT OF THE RESEARCH METHOD

To make valid decisions regarding allocation of limited resources, decision makers need quantitative data bases reflecting resource demands to meet desired objectives. In a coordinated dietetic program, the desired objective is to allocate limited resources in such a way as to assist the greatest number of students to achieve entry-level competencies. The number of students requiring clinical experiences will determine the demand for clinical instructor time and clinical facility time in relation to the instructional strategy used to achieve desired competencies.

Reliable data bases for resource use based on instructional strategies have not been established, or if such bases exist they have not been reported in the literature. Until a program establishes quantitative data bases for demands on resources, decisions will be made subjectively based on intuition and experience.

Framework for a Data Base

A framework was developed for establishing and validating a quantitative data base for the first year of the professional phase of a coordinated dietetic program. Using the systems approach pertinent constraints for efficient use of resources were identified to determine types of data needed for decision making. Constraints identified varied from such factors as the number of required

clinical courses, desired competencies, available resources, and the efficiency of the learning situation. Five members of the CUP faculty, with a combined experience of thirty-five years in dietetic education, indicated that decisions generally required data related to the use of resources. These resources were identified as clinical instructor time, student time, and clinical facility time. The investigator chose to develop a single constraint representation of the coordinated program reflecting available clinical instructor time. The coordinated program has a greater control of clinical instructor time than it does of student time or of clinical facility time. It was assumed that students could devote as much time as needed to complete the work and as such was not considered as a limiting resource. Also, it was assumed that clinical instructors considered student time demands when deciding on the instructional strategy mixes to use for the clinical units.

Time available from clinical facilities for the first year clinical experiences for CUP was specified in a contractual agreement between the program director and the clinical facilities. As such, available clinical facility time was not considered as a limiting resource for this research. It was assumed that as much time as needed for first year clinical experiences for students could be arranged.

I. REQUIRED COURSES

This study was limited to the three patient care clinical courses required for the first year of the professional phase of the

program for which clinical instructors were responsible. Each clinical course is coordinated with a required didactic course. The coordinated courses are designed to allow first year students to achieve competencies required to enter the second year of the professional phase. The number of clinical courses that a student must complete during the two year professional phase affects the degree to which a student attains entry-level competencies for the profession. Likewise, the number of clinical courses successfully completed by a student in the first year of the professional phase affects the level of competence attained for progression into the second year. Each first year clinical course completed by a student earns the student one credit hour. Students must spend three to four clock hours per week in clinical experiences for each credit hour earned.

A set of clinical experience units with enabling objectives support the objectives of each clinical course. The desire is to select the instructional process for each unit within resource constraints which will meet the needs of the greatest number of students and which will assure attainment of the required level of competency.

II. COMPETENCIES

The major objective of the first year of the program is to provide students patient care clinical experiences designed to achieve maximum competency attainable for progression into the second

year of the program. The instructional strategy mix used could have some effect on the degree to which students achieve competencies. An instructional strategy is a method of teaching such as lecture, group discussion, or videotaped simulation. An instructional strategy mix is a combination of two or more instructional approaches.

The desired competencies for progression into the second year of the program are related to the performance of students in such areas as providing nutritional care to patients, interpreting medical chart notations, modification and individualization of dietary regimens in relation to the dietary prescription, and psycho-social needs of the patient. Student performance is affected by a number of interrelated factors. According to Block (1971) the amount of time that students will devote to learning the material is affected by the students' preference for the instructional strategies. Other factors that are pertinent to a student's performance in a coordinated program include the quality of available clinical experiences and the amount of clinical instructor time available for instruction.

III. AVAILABLE RESOURCES

The primary resources for a coordinated program are clinical sites, available student time, and available clinical instructor time to perform direct teaching activities. The program is primarily concerned with maximizing returns on the use of available clinical instructor time.

Clinical Sites

The quality of clinical experiences is influenced by such factors as the type of dietetic care required by patients and the level of dietetic care normally provided by staff dietitians of the clinical facility. The number of available clinical experiences in a facility is limited by the number of patients requiring the type and level of dietetic care that can be provided by students at a given point in time. For example on a visit to the clinical facility there may be a number of available experiences for students to provide dietetic instruction for diabetic patients, however, if diabetic diets have not been discussed in the didactic course, students are not prepared to provide the instructions, thus the number of available clinical experiences would be reduced. Attempts by students to provide diabetic diet instructions on this visit would not result in a quality clinical experience for the students. If students were trained to provide diabetic diet instructions and the facility had a large number of such instructions to give then the experience would be a quality experience. A quality clinical experience is one in which the students are prepared to achieve the objectives of the clinical experience unit while in the clinical facility.

A decrease in the number of students assigned to a clinical facility increases the potential of students participating in an increased number of quality clinical experiences. This in turn increases the potential for achieving desired competency levels. To assign a decreased number of students to a clinical facility, if

the total class size is constant, means that more clinical sites must be available to provide learning experiences for students. Clinical sites include hospitals, nursing homes, health care agencies, and institutions such as schools, day care centers, and churches.

Hospital related experiences. Many of the clinical experiences required for first year students take place in the hospital setting. The contract with the participating hospital requires supervision of students by a clinical instructor. The agreed number of students in the facility at one time with a clinical instructor was three. The rationale for this ratio was to provide sufficient guidance to students and minimize disruption of routine activities. By having a clinical instructor to student ratio of 1:3, clinical instructors have sufficient time to observe and to assist each student as needed to assure that quality dietary care was provided. The 1:3 ratio increases the opportunity for quality learning experiences for students. The number of students accepted in the program is related to available clinical instructor time.

Available Student Time

The time that students devote to clinical courses is a function of the number of credit hours for which a student is enrolled and the amount of time that a student is willing to give to achieve competency. Clinical instructors when selecting the instructional strategy mix for a clinical experience unit consider demands placed on students' time. As a general guideline, clinical instructors allow an average of four clock hours per week demand on

student time per credit hour. The four hours include time devoted to preparation by students for the experience, the actual clinical experience, attendance at group and/or individual conferences for pre-experience activities, and time needed for completion of written assignments. Available student time is a factor in the decision of which instructional strategy mix to use, but not to the degree that available clinical instructor time is considered.

Available Clinical Instructor Time

There is a direct relationship between clinical instructor time available and the number of students which can be accepted for first year clinical experiences. Available clinical instructor time is the time that clinical instructors have to interact with students in teaching activities. There are a number of factors that affect the amount of available time such as administrative decisions regarding staffing and indirect teaching activities.

The number of full-time equivalents (FTE) budgeted for clinical instructor positions may be filled by full-time or part-time instructors. Use of part-time clinical instructors allows for better supervision of students engaged in concurrent clinical experiences and provides needed manpower for supervision when using low instructor to student ratios. Concurrent clinical experiences facilitate scheduling of courses and experiences.

Participation on departmental committees and attending departmental meetings are examples of indirect teaching activities of the academic unit that place demands on clinical instructor time. Other

indirect teaching activities are programmatic functions such as attending clinical instructor meetings, advising students, attending didactic courses, conferring with didactic faculty, developing student master schedules, developing and validating evaluation instruments or checklists, and processing and screening applicants for the program. Indirect teaching activities are those functions that need to be performed to maintain the coordinated program. The reduction of available clinical instructor time for teaching due to nonteaching activities may cause clinical instructors to select instructional strategy mixes that require less time for instruction. Instructional strategy mixes that require less clinical instructor time may or may not be as effective as those mixes requiring more clinical instructor time.

Direct teaching activities are those that a clinical instructor performs in the process of completing a clinical unit. These activities are categorized as planning, preparation, pre-experience conferences, supervision of experience, and evaluation.

Planning. Planning is defined as the conceptualization of the clinical unit. In the conceptualization process clinical instructors make decisions reflecting consideration of the desired competency level, demand on clinical instructor time, demand for clinical sites, demand on student time, suitability of instructional strategies and depth of instruction.

Preparation. The preparation function includes activities that facilitate instruction, supervision, and evaluation of students in clinical experiences. Preparation activities include:

a. Reading references prior to attending pre-experience conferences.

b. Making arrangements for guest speakers.

c. Obtaining necessary resources such as videotape equipment, handouts, and food models.

d. Developing handout materials.

e. Developing examinations and keys for grading examinations and assignments.

f. Scheduling clinical experience units.

g. Updating references.

h. Making references available for students.

i. Finalizing arrangements with clinical facility personnel.

j. Preparing for lectures, other presentations, and clinical experiences.

Pre-experience conferences. The pre-experience conference is used to inform students and/or clinical facility personnel of what is expected for completion of the clinical experience unit whether the experience is actual or simulated. For the student, the pre-experience conference may be a group meeting or individual meeting between a student and the clinical instructor. During the pre-experience conference the clinical instructor may present new course material to students via lecture, group discussion, demonstration, or any other suitable instructional strategy. Material presented may reinforce or expand didactic course material related to the clinical experience. The pre-experience conference may be used to assess students' preparedness for the clinical unit.

The clinical instructor and a representative of the clinical facility together determine the experience. This includes what is

expected of the facility personnel, the actual activity for the student, and the responsibilities of the clinical instructor. The clinical instructor will inform the facility representative of the type and number of diet instructions or other types of dietary care to be provided by the students and clarify the needs of the experience. Usually this meeting is to reinforce arrangements made during the planning process.

Supervision of the experience. Supervision is the physical presence of the clinical instructor in the clinical setting for an experience, whether in a clinical facility or simulated in the classroom, at the time the experience is taking place. The clinical instructor assumes responsibility for the actions of the students. Included in this time is the instructor's travel to and from the clinical setting.

Evaluation. Evaluation is the process of assessing student performance and student interpretation of the learning situation. The interpretation of the learning situation by the student allows the clinical instructor to assess whether the student is aware of the concepts involved, the skills and attitudes necessary for completion of the activity, and the routines required to perform the activity in the clinical setting. Assessing the effectiveness of the learning situation is an important component of evaluation. Evaluation is divided into three areas:

a. Post-experience conferences: This activity may be on an individual or group basis. Factors contributing to the use of clinical instructor time besides the actual conference includes preparation for the conference and writing any reports or completion of forms following the conference.

b. Grading: Grading includes the evaluation of written assignments, reading log books, and reviewing audio- and/or videotapes. Factors that contribute to demand on clinical instructor time include discussing and developing evaluation criteria with other clinical instructors.

c. Discussion with clinical facility personnel: This is a means of evaluating the effectiveness of the learning situation. Clinical instructors may discuss outcomes of the individual student, as well as the effectiveness of the learning situation at the conclusion of the experience.

In developing a clinical experience, a clinical instructor in the dietetic program considers the potential demand on available clinical instructor time, clinical sites available, the number of students, demands on student time, and competency contributions of the experience. The instructional strategy mix that will use resources the most efficiently while achieving desired competencies should be determined by the clinical instructor.

IV. EFFICIENCY OF LEARNING SITUATIONS

For the coordinated program, the most important relationship that must be considered is the competency contribution per clinical instructor hour. The efficiency of a learning situation is the relationship between the demand on a resource and the potential competency level attainable by students. Since available clinical instructor time is considered by administration as the limited resource of major concern, a measure of efficiency of the learning situation must reflect demands on clinical instructor time.

Outcomes of Clinical Instructor Time

Outcomes from clinical instructor time include the number of students completing an experience, the number of student credit hours produced, the number of qualified entry-level dietitians graduated by the program, and the number of services and patient contacts provided to the clinical facilities. One factor that contributes to the competency level obtained by students is the selection of the most desirable instructional strategy mix for an experience to meet individual students learning style. Program faculty consider the efficiency of a learning situation when selecting instructional strategy mixes as well as the potential competency level attainable by students.

Competency Contributions

The instructional strategy mix used must allow for at least achievement of a minimal level of competency. Intuitive assessment by clinical instructors is used to estimate the contribution to competency for a clinical experience unit. Instructors who have used a number of instructional strategies have an idea of this effectiveness in relation to the objectives of a clinical unit. In the absence of objective data regarding the effectiveness of various instructional strategy mixes, intuitive assessment of effectiveness by clinical instructors provides the basis for decision making.

Clinical instructor time required to perform direct teaching activities for an instructional strategy mix is influenced by the instructional strategies included in the mix, the number of students

requiring the clinical experience, and the ratio of clinical instructor to students needed for supervision. Experienced clinical instructors are the best judges of time required to perform direct teaching activities for an instructional strategy mix for a given class size and the desired clinical instructor to student ratio.

V. PROCEDURE FOR ESTABLISHING AND VALIDATING DATA BASES

Decisions based on valid quantitative data are more reliable and more consistent with the overall goals of an enterprise than intuitive decisions. In situations, such as found in CUP's, where data bases are not available to assist in the decision making process, a method for developing such bases must be designed and validated to increase effectiveness of the decision making process. To select efficient learning situations for clinical units, quantitative data should include time demands of clinical instructors, as well as competency contributions for different instructional strategy mixes.

A process was developed for establishing and validating teaching demands and competency contributions for selected instructional strategy mixes. The process begins with the identification of clinical experience units and instructional strategies suitable for each unit and systematically progresses through application and analysis of time estimates and competency contributions of each mix. A linear programming model and a heuristic technique were applied to the time demands and competency contribution ratings of the instructional strategy mixes to maximize student competency by selecting the most efficient learning situations.

Experience Units

The Manuals for Clinical Experiences for the Junior Year (Beach, et al., 1977 and 1980) were reviewed to identify clinical experience units required for first year clinical courses. Each clinical experience unit possessed a set of learner objectives that were designed to contribute to the desired competency of students entering the senior year of the program. Suggested learning activities were listed as well as suggested references.

Instructional Strategies

Sixteen potential instructional strategies were identified as available for use in the program. The selection of instructional strategies used for a unit is the responsibility of the clinical instructor. Four questionnaires were developed to ascertain pertinent data about the instructional strategies used in the program (Appendix A).

Training Session for Panelists

Following approval of this project by the Human Subject Review Committee, a training session was conducted by the investigator to familiarize clinical instructors, students, and clinical facility personnel with the objectives of the study. Explanation of the procedure to be used and the rationale for their participation were given. The four questionnaires were pilot tested by application of each to a clinical experience unit. Questionnaire I was designed to identify the instructional strategy mixes currently used for the clinical experience units. Elemental times were obtained from the

responses to Questionnaire II. Alternative instructional strategy mixes were identified by panel responses to Questionnaire III. Questionnaire IV was designed to solicit competency contribution ratings of the identified instructional strategy mixes for all courses.

Verification of Base Instructional Strategy Mixes

Eleven panels, each consisting of a clinical instructor, three students who had completed the clinical experience unit, and a facility representative when appropriate, verified the use of an instructional strategy mix by responding to Questionnaire I for each clinical experience unit presented in the manuals. The instructional strategy mixes used by the program during Winter 1980 through Fall 1980 were the basis for time estimates. This mix of instructional strategies was the base data for the study. Each panel completed Questionnaire I for at least two clinical experience units.

Elemental Times

Direct teaching activities were the basis for estimating demand on clinical instructor time. Teaching activities were considered as elements of an instructional strategy. All instructional strategies required two or more teaching activities. An element was defined as the smallest component of the teaching process as related to a specific instructional strategy that could be measured with a reasonable degree of accuracy. Questionnaire II was developed to ascertain estimates of elemental times for clinical instructors to

perform teaching activities for various instructional strategies with a class size of fifteen students, the number of students in the program at the time of the study. Questionnaire II was completed by a panel of three clinical instructors. Times generated for the instructional strategies were analyzed to identify common characteristics of elements. Two major classifications resulted based on the relationship of the element to the number of students in the class. Elemental times that clinical instructors thought had no relationship to class size were termed fixed elements. Variable elements were defined as those direct teaching activities for which demand on clinical instructor time was directly influenced by the number of students enrolled in the class. Some variable elemental times were directly proportional to the number of students, while other variable elements were directional only. Six assumptions were made by the panel of clinical instructors responsible for first year experiences.

Assumption 1. The time required for a class activity such as lecture or group discussion was independent of the number of students enrolled for the class. Therefore, lecture and group discussion were considered as fixed elements and the time estimates for these strategies were the same regardless of class size.

Assumption 2. A clinical instructor/student ratio of 1:3 was used for hospital related experiences because of the hospital's desire to minimize the number of changes in routine activities of staff dietitians. The following rules were used for hospital related experiences: (1) When the number of students to be scheduled for

clinical experiences exceeded the nearest multiple of three by only one student the additional student was attached to a group making the clinical instructor to student ratio for that group 1:4; and (2) when the number of students to be scheduled exceeded the nearest multiple of three by two students an additional group was scheduled.

Assumption 3. For some nonhospital related experiences clinical instructors did not supervise students because the agencies providing the clinical experience preferred to provide qualified staff for supervision. For such clinical experiences clinical instructors communicated with the agency's representative to plan the experience and following the student's participation, to evaluate performance of the student and to assess effectiveness of the experience.

Assumption 4. Some of the activities performed by clinical instructors were student dependent. Time required for clinical instructors to perform these activities was linearly related to the class size. Such activities were grading papers, examinations, or projects, as well as individual conferences. Time required per student was determined for these activities.

Assumption 5. A clinical instructor to student ratio of 1:5 was preferred for videotaped simulations. This included the actual taping and the critiquing of students' performances.

Assumption 6. Two levels of simulated problems, excluding videotaped simulations, were identified by clinical instructors for first year clinical experiences. Level 1, the lower of the two, included simulated problems used as orientation or introductory

experiences for students. Level 1 simulated problems were designed to be at the knowledge level of the taxonomy of learning (Bloom, et al., 1956). Level 2 simulated problems were designed to satisfy the description for learning experiences at the application level. Level 2 simulated experiences replaced actual clinical experiences and satisfied the requirements for desired competency level for the unit.

Application of Elemental Times

Elemental times generated by clinical instructors for completion of Questionnaire II were applied to the base instructional strategy mix for each clinical experience unit to ascertain total clinical instructor time required for the clinical unit. The investigator used the following rules to apply elemental times: (1) select the instructional strategy mix for which clinical instructor time was to be estimated; (2) break the instructional strategy into its fixed and variable elements; (3) record the estimated time for all fixed elements; (4) record estimated time required for each variable element based on ratios for clinical instructor to students or on a per student basis; and (5) total fixed and variable elemental times.

Validation of Time Estimates

Clinical instructors responsible for first year clinical courses validated time estimates for base instructional strategy mixes by consensus. Consensus was defined as 100 percent of the

clinical instructors agreeing to the time estimate. When consensus was not achieved, the elements that made up the mix were examined independently. The elemental time generated by the clinical instructors for Questionnaire II was analyzed for accuracy. If the panel of clinical instructors decided that an elemental time was inaccurate a new time was generated after discussion of why the original elemental time was inaccurate. Time estimates for elements were revised for such reasons as, the original elemental time estimate was based on the wrong ratio of clinical instructor to students, or the estimate was assigned to the incorrect category for fixed or variable elements.

After the time estimates for the elements were revised, the investigator applied the revised elemental times to the base instructional strategy mixes. The panel met to validate the new time estimates. The process was repeated until consensus was achieved for the time estimates for the base instructional strategy mixes.

Alternative Instructional Strategy Mixes

Alternative instructional strategy mixes for clinical units were generated by completion of Questionnaire III. The eleven panels that completed Questionnaire I were asked to complete Questionnaire III for the same clinical units. The panel members following a round robin presentation of the alternatives discussed the feasibility of each alternative. All members of the panel had to agree that an alternative was suitable as a replacement for the base strategy mix. Following discussion of the merits of an alternative mix and if the

panel agreed by consensus that the mix met required minimal competency level, the mix was included as an alternative. The base instructional strategy mix and its alternatives provided a pool of strategy mixes from which to select for a clinical experience unit.

The same guidelines used to apply elemental times to base strategy mixes were used to determine demand on clinical instructor time for the alternatives. Likewise, validation of time estimates for alternatives was achieved as for the base mixes. If a time for an element was revised during validation of time estimates, time estimates for base mixes were adjusted accordingly.

Elemental Timetables

After validation of time estimates for both the base and alternative instructional strategy mixes, fixed and variable elemental times were established based on a class size of fifteen students. Using these elemental times clinical instructors estimated times for class sizes of ten, twenty, and twenty-five students. The investigator applied the elemental times to the base and alternative strategy mixes for the varying class sizes. Validation of time estimates was accomplished as previously described. Adjustments to previous time estimates were made as needed reflecting any changes of elemental times.

Perceived Competency Contribution Ratings

The panel, composed of three clinical instructors responsible for first year clinical experiences estimated competency contribution

values of base and alternative strategy mixes. The competency level of students entering the second year of the professional phase of the dietetic program must be considered at some point by decision makers. Competency contribution ratings for strategy mixes, whether subjectively or objectively ascertained, must be a part of a data base for such professional curricula as found in CUP's. Because of their experience in designing clinical experiences to meet desired competency levels, clinical instructors were chosen to complete Questionnaire IV.

Using a numerical scale from one to five, perceived competency contribution was estimated for each strategy mix. Five represented the greatest contribution to competency and one the least. Consensus of the panel was obtained for each.

Use of Data Bases

Staffing demands for meeting base, minimum, and maximum competency ratings for class sizes of ten, fifteen, twenty, and twenty-five students were determined. Staffing levels were calculated independently for meeting base competency, minimum competency, and maximum competency ratings for each of the class sizes under the following conditions: one clinical instructor would be hired for the academic year on a full-time, three-quarter time, or half-time basis; and, the course with the greatest demand on clinical instructor time determined available clinical instructor time. For example, if course 1 required a half-time clinical instructor for minimum competency and courses 2 and 3 required a three-quarter

time clinical instructor, then the least number of clinical instructor positions required for the academic year would be a three-quarter clinical instructor. Problems were formulated to study the relationships of competency contribution to clinical instructor time required and the class size. The problems were designed to optimize use of available clinical instructor time over three academic quarters while increasing competency contribution per clinical instructor hour.

VI. DEVELOPMENT OF LINEAR PROGRAMMING PROBLEMS

A computerized integer linear programming model was used to identify strategy mixes that would maximize competency contribution ratings of a clinical course without violating limitations of available clinical instructor time. Several assumptions were made regarding available clinical instructor time. It was assumed that the number of hours per F.T.E. per week was forty because no faculty member was expected to keep office hours or be scheduled for work on weekends on any regular basis. However, instructors were considered as professionals and thus were expected to put in whatever time it took to get the job done. The time devoted to work beyond forty hours per week was an individual decision based on personal work habits and efficiency.

The second assumption was that an academic quarter was ten full weeks. In actuality, the length of the academic quarter at The University of Tennessee, Knoxville varied from 9.5 to 10.5 weeks.

The third assumption was that eighty percent of a full-time clinical instructor's time was devoted to direct teaching activities. No data were available to indicate to what degree clinical instructors in a CUP devote to indirect teaching activities. The investigator used twenty percent based on personal experience as a clinical instructor for six years.

To determine available clinical instructor time for each full-time instructor for first year clinical courses, the following formula was used:

$$P = FCW(1-N)$$

Where:

P = available clinical instructor time

F = the number of full-time faculty equivalents assigned to teach a first year clinical course

C = number of hours per F.T.E. per week

W = number of weeks in a quarter

N = fraction of time devoted to indirect teaching activities

Available clinical instructor time (P) for a full-time clinical instructor was computed as 320 hours per quarter. The values used for the determination were as follows:

$$P = (1)\ (40\ \text{hrs./week})\ (10\ \text{weeks/quarter})\ (1 - 0.20)$$

The available clinical instructor time (P) for a part-time clinical instructor was calculated under the assumption that the amount of time devoted to indirect teaching activities by a part-time clinical instructor was equal to the number of hours devoted by a full-time clinical instructor. It was assumed that part-time

clinical instructors would not be exempt from indirect teaching activities such as attending departmental meetings and didactic courses. Thus, if eighty hours per quarter were devoted by a full-time clinical instructor, a part-time clinical instructor would also devote eighty hours to these activities. To reflect this assumption, available time for a part-time clinical instructor was calculated using the following equation:

$$P = FCW - N(F_1CW)$$

Where:

P = available clinical instructor time

F = the number of full-time faculty equivalents assigned to teach a first year clinical course

C = number of hours per F.T.E. per week

W = number of weeks in a quarter

N = fraction of time devoted to indirect teaching activities

F_1 = number of individuals filling positions

Substituting 0.50 and 0.75 respectively for F for a half-time and a three-quarter time clinical instructor resulted in 120 hours and 220 hours available for instruction.

Clinical Instructor Decision Model (CIDMO)

The perceived competency contribution rating of a clinical course was depicted as the following mathematical model with an "either or" proposition regarding the variables, instructional strategy mixes. Each course represents an academic quarter.

$$C_k = \sum_{i=1}^{i=n} \sum_{j=1}^{j=n} b_{ij} X_{ij}$$

X_{ij} = 0, 1 and integer

Where:

C_k = perceived competency contribution rating for course k for an academic quarter

X_{ij} = the ith instructional strategy mix for jth clinical experience unit

b_{ij} = perceived competency contribution rating of ith instructional strategy mix for jth clinical experience unit

n = maximum unit number used for identification

Instructional strategy mixes were specific for a clinical course and were used only for the course for which they were developed. Each instructional strategy mix possessed an attribute, perceived competency contribution rating. Each course contributed to competency at a level equivalent to the sum of the contributions of the instructional strategy mixes used. Thus competency contribution for the first year clinical courses of the professional phase of the dietetic program was represented by the following equation:

$$\text{Total competency} = \sum_{k=1}^{k=n} C_k$$

Where:

C_k = perceived competency contribution rating for course k

k = 1, 2, and 3

To formulate a CIDMO problem for each instructional strategy mix,

the competency contribution and the demand for clinical instructor time must be known. Also, total available clinical instructor time must be determined.

The demand on clinical instructor time for the mixes for four different class sizes were coefficients for the instructional strategy mixes in the constraint statement of the CIDMO problem.

The problems designed to maximize perceived competency contribution ratings for each course were developed for CIDMO as an integer linear programming problem and were depicted as follows:

Objective function:

$$\text{Maximize } Z = \sum_{i=1}^{i=n} \sum_{j=1}^{j=n} b_{ij}X_{ij}$$

$$X_{ij} = 0, 1 \text{ and integer}$$

Subject to:

$$\sum_{i=1}^{i=n} \sum_{j=1}^{j=n} a_{ij}X_{ij} \leq P$$

Where:

Z = contribution to competency

X_{ij} = the ith instructional strategy mix for jth clinical experience unit

b_{ij} = perceived competency contribution rating of ith instructional strategy mix for jth clinical experience unit

a_{ij} = demand on clinical instructor time for ith instructional strategy mix for jth clinical experience unit

P = available clinical instructor time (constant for each course)

n = maximum unit number used for identification

Problem Sets

Four sets of problems were developed for the computerized Clinical Instructor Decision Model to optimize use of clinical instructor time while increasing competency contribution ratings for the junior year clinical courses. A problem set was developed for each class size studied and denoted in the following manner: Problem Set 1 was for ten students; Problem Set 2 was for fifteen students; Problem Set 3 was for twenty students; and, Problem Set 4 for twenty-five students. To determine the minimum and maximum competency contribution ratings for each course, the instructional strategy mixes that gave the lowest and highest rating for each clinical experience unit were identified. The amount of clinical instructor time required for a class of ten, fifteen, twenty, and twenty-five students was determined for each course by summing the time required for each set of strategy mixes identified. When two or more strategy mixes were tied for the lowest or highest contribution to competency for a clinical unit, the one with the least demand on clinical instructor time was used. The number of clinical instructor positions required for minimum and maximum competency for the four class sizes were based on the course that required the greatest number of clinical instructor positions. Each problem set was designed to study the effects on competency rating for CIDMO applications when available clinical instructor time was equal to staffing level required for base or minimum competency rating. The objective of CIDMO was to improve competency contribution rating for base or minimum competency

staffing levels. The problem sets were also studied with the use of a heuristic technique designed to increase competency contribution rating for a course.

VII. HEURISTIC MODEL

The Heuristic Routine for Selecting Instructional Strategy Mixes (HRSISM) was developed to manually select instructional strategy mixes to maximize competency contribution rating for a course. The procedure developed allows for manipulating variables into and out of the solution for a single constraint, "zero-one" integer problem to derive an optimal feasible (maximize the objective function) solution for small problems. The sixteen step procedure developed was applied to a sample two variable problem (Appendix B) and the CIDMO problems.

VIII. ANALYSIS OF DATA

A timetable was developed for the elemental times for direct teaching activities and instructional strategies. Elemental times were applied to the instructional strategy mixes to obtain time estimates. Time estimates were analyzed for base and alternative strategy mixes. Estimates for base strategy mixes were summed to obtain demand on clinical instructor time required for class sizes of ten, fifteen, twenty, and twenty-five students. The percent of clinical instructor time devoted to various teaching activities was determined for base strategy mixes.

The frequency of use of instructional strategies were determined for base strategy mixes. The percent of clinical experience units using an instructional strategy was calculated.

Total competency contribution of the base strategy mixes for the three clinical courses was determined. Likewise, competency contribution for each course was determined as well as the mean competency contribution rating of a strategy mix for each course.

Comparisons were made between competency contribution ratings of base and alternative strategy mixes. Demands on clinical instructor time for base and alternative strategy mixes were compared.

Data were analyzed to ascertain differences between the demands on clinical instructor time when the class size was ten, fifteen, twenty, or twenty-five students for base strategy mixes. The effect of class size on use of clinical instructor time was ascertained by percentages.

CIDMO and HRSISM solutions were compared to base strategy mixes and strategy mixes that gave minimum or maximum competency ratings. Comparisons were made to ascertain differences in the demands on clinical instructor time per clinical experience unit and per student. The course competency ratings and total competency ratings were compared for the various solutions. Comparisons were made for the slack time generated for the solutions. Strategy mixes included in CIDMO and HRSISM solutions were compared to base mixes and mixes giving minimum and maximum competency ratings to ascertain differences in the strategies used.

CHAPTER IV

RESULTS AND DISCUSSION

Questionnaires were completed by clinical instructors, clinical facility personnel, and first year dietetic students to collect resource demand data for clinical experience units. Elemental Time Tables were developed for identified teaching activities and instructional strategy mixes for four class sizes based on the intuitive judgement of experienced clinical instructors. Competency contributions were estimated for each instructional strategy mix.

I. TIME ESTIMATES FOR BASE INSTRUCTIONAL STRATEGY MIXES

Sixteen instructional strategies were identified from a review of the clinical experience manuals used by the dietetic program. The use of an instructional strategy was verified by clinical instructors, students, and clinical facility personnel responses to Questionnaire I. The instructional strategy mixes used for the three clinical courses for Winter, Spring, and Fall Quarters 1980, were identified and termed base instructional strategy mixes. There was one instructional strategy mix for each of the twenty-three clinical experience units required for the first year courses. Six, eight, and nine instructional strategy mixes were identified respectively for clinical experiences for basic nutrition, nutrition and disease, and foods and the consumer.

Clinical instructors estimated time required to perform direct teaching activities such as preparation, supervision, and conferencing

for each instructional strategy. Estimates were used to develop an elemental time matrix.

Elemental Times

Times estimated for teaching activities were categorized as fixed or variable elements (Table 1). Time required to perform a fixed element did not vary with class size, whereas time required to perform variable elements increased or decreased with increases or decreases in class size.

Fixed elements. The time required of clinical instructors to perform the teaching activities of planning, preparation, pre-experience conference, supervision, and post-experience conference were fixed for several of the instructional strategies. Planning time was considered as a mean of clinical instructor time estimates devoted to planning clinical experience units, rather than the time estimated to plan for an instructional strategy. For all twenty-three clinical units, planning was established as three hours per unit.

Twenty-six combinations of a teaching activity and an instructional strategy were considered as fixed elements. Nine of the fixed elements were for preparation time needed by clinical instructors for nine instructional strategies. The teaching activities, pre-experience conference and post-experience conference, each had five fixed elements. Proctoring examinations was the only supervision and instructional strategy combination found to have the same elemental time regardless of class size.

TABLE 1. Fixed and Variable Elemental Times for Clinical Instructors to Perform Teaching Activities Based on Instructional Strategies and Class Size.

Teaching Activity and Instructional Strategy	Fixed Elemental Time	Variable Elemental Times 10 Students	15 Students	20 Students	25 Students
	Hours				
PLANNING	3.00				
PREPARATION					
Lecture	2.00				
Group Discussion	2.00				
Individual Discussion		0.25	0.25	0.50	0.50
Reading List	0.50				
Computer Assisted Instruction	0.50				
Videotaped Simulation		6.00	7.00	8.00	9.00
Audiotaped Simulation		2.00	2.00	3.00	3.00
Computer Simulation	4.00				
Simulated Problem Level 1	2.00				
Simulated Problem Level 2	2.00				
Actual Hospital Experience		1.50	2.50	3.50	4.00
Nonhospital Experience	2.00				
Self-paced Module	0.50				
PRE-EXPERIENCE CONFERENCE					
Lecture	1.00				
Group Discussion	1.00				
Individual Discussion		2.50	3.75	5.00	6.25
Computer Assisted Instruction		1.00	1.00	2.00	2.00
Computer Simulation		1.00	1.00	2.00	2.00
Simulated Problem Level 1	0.50				
Simulated Problem Level 2	1.00				
Actual Hospital Experience		1.00	1.50	1.50	2.00
Nonhospital Experience	1.00				
SUPERVISION					
Videotaped Simulated		3.00	4.25	5.50	7.00
Actual Hospital Experience		9.00	15.00	21.00	24.00
Examinations	2.00				
Oral Presentation		5.00	7.50	10.00	12.50
POST-EXPERIENCE CONFERENCE					
Lecture	0.50				
Group Discussion	0.50				
Individual Discussion		2.50	3.75	5.00	6.25
Videotaped Simulation		6.00	9.00	12.00	15.00
Audiotaped Simulation		5.00	7.50	10.00	12.50
Simulated Problem Level 1	0.50				
Simulated Problem Level 2	0.50				
Actual Hospital Experience		1.00	1.50	1.50	2.00
Nonhospital Experience	0.50				
EVALUATION AND GRADING					
Examinations	0.50*				
Written Assignments	0.50*				
Oral Presentations	0.25*				
Case Studies	1.00*				
Log Books	0.08*				

*Times are on a per student basis.

Variable elements. Two types of relationships characterized the variable elements. Time required to perform some variable elements were determined on a per student basis. Other variable elemental times were determined according to ratios of clinical instructor to students deemed necessary for desired levels of supervision. Time needed for evaluation and grading of student performances and/or written assignments was considered as a per student variable as was supervision of oral presentations. One-half hour per student was projected as the demand on clinical instructor time for an oral presentation. This estimate included time for feedback immediately following the presentation. This activity was not the same as the feedback given when a checklist was completed and discussed with the student.

The variable elements resulting from a required ratio of clinical instructor to students were for videotaped simulation and actual experiences. Preparation, supervision, and post-experience conference times varied for different class sizes for videotaped simulation. The variance in preparation time was attributed to one or both of two factors. Developing additional simulated situations by clinical instructors was one contributing factor. The other factor was related to a group of activities regarding videotape equipment. Some of these activities were scheduling a room, securing, and transporting videotape equipment for multiple sessions. Supervision time increased for videotaped simulation because of the multiple taping sessions required for larger class sizes. Supervision time increases for videotaped simulation were not considered a function of the number of students because students were not required to simulate for a precise

time frame. Three to five students were assigned for a block of time for taping sessions and for post-experience conferences. The experience was limited to a block of time regardless of the size of the group.

Preparation time required for audiotaped simulation was variable. Preparation time increased for audiotaped simulation when clinical instructors had to develop more simulated situations for larger class sizes. The development of additional situations was necessary to prevent students from becoming bored when students had to play both roles in the exercise and to minimize repetition of the same approach used by another student in completing the exercise. The increase in time for post-experience conferences for audiotaped simulation was a per student function.

Pre-experience conference time for computer simulations and computer assisted instruction increased as the size of the class increased due to the limited space for demonstration of the equipment. With a class size of twenty to twenty-five students, clinical instructors indicated that for instruction and/or demonstration to be effective the class would be divided into two groups. Thus, clinical instructor time increased accordingly.

Clinical Instructor Estimates for Base Strategy Mixes

Demand on clinical instructor time for each base instructional strategy mix was determined for a class of fifteen students using the elemental times. Total time required of clinical instructors for each course was calculated by summing the time estimates for each base

strategy mix. Demand on clinical instructor time for the three first year clinical courses was 667 hours, approximately 188 hours for clinical experiences in basic nutrition, 263 hours for nutrition and disease, and 216 hours for foods and the consumer (Tables 2, 3, 4). Averaging of data for the three courses indicated the demand for clinical instructor time per clinical experience unit was 29 hours. Clinical instructor time per unit for basic nutrition was approximately 21 hours, for nutrition and disease, 43 hours, and for foods and the consumer, 27 hours. Based on comments made by clinical instructors the investigator expected to find more time needed for clinical units for basic nutrition. Clinical instructors indicated that students required more individual attention during the first quarter than during second or third quarters. However, this factor did not appear to be so for the estimates derived. Therefore, the additional attention given during the first quarter must be in the form of indirect teaching time, such as counseling, advising, and helping students develop affective behaviors.

Estimates for Various Class Sizes

Elemental times were applied to base instructional strategy mixes for class sizes of ten, twenty, and twenty-five students for the three first year courses. Total instructor time required per term was 494, 840, and 978 hours respectively for ten, twenty, and twenty-five students per class. Clinical instructor time per course increased as the size of the class increased. Efficiency of clinical instructor time increased as the size of the class increased as evidenced by a

TABLE 2. Demand on Clinical Instructor Time Using Base Instructional Strategy Mixes for Basic Nutrition Clinical Experience Units.

Clinical Experience Unit	Strategy Code*	Number of Students Per Class			
		10	15	20	25
		Hours Per Class			
Interviewing	N_{11}	24.50	29.75	35.00	40.50
Medical Records	N_{21}	15.50	18.00	20.50	23.00
Vitamins "n" Minerals	N_{31}	15.00	17.50	20.00	22.50
Maternal Nutrition	N_{41}	15.00	17.50	20.00	22.50
Infant and Child Nutrition	N_{51}	11.50	14.00	16.50	19.00
Adolescent Nutrition	N_{61}	11.50	14.00	16.50	19.00
Senescent Nutrition	N_{71}	7.00	8.25	9.50	10.75
Patient Interviewing	N_{81}	21.50	31.00	40.50	46.50
Case Study	N_{91}	26.50	38.50	50.50	59.00
TOTAL		148.00	188.50	229.00	262.75
Average time per unit**		16.50	21.00	25.50	29.00
Average time per student**		15.00	12.50	11.50	10.50

*See Appendix C for instructional strategies.

**Rounded off to the nearest half-hour.

TABLE 3. Demand on Clinical Instructor Time Using Base Instructional Strategy Mixes for Nutrition and Disease Clinical Experience Units.

Clinical Experience Unit	Strategy Code*	Number of Students Per Class: 10	15	20	25
		Hours Per Class			
Interviewing and Counseling	D_{11}	29.00	36.75	44.50	52.50
Charting	D_{21}	16.00	19.75	23.50	27.25
Exchange Systems	D_{31}	24.50	30.75	37.00	43.25
Nutritional Assessment	D_{41}	40.00	61.00	82.00	95.00
Nutritional Care Plans	D_{51}	42.50	64.75	87.00	101.25
Case Study	D_{61}	34.00	49.75	65.50	77.75
TOTAL		186.0	262.75	339.50	397.00
Average time per unit**		31.00	44.00	56.50	66.00
Average time per student**		18.50	17.50	17.00	16.00

*See Appendix C for instructional strategies.

**Rounded off to the nearest half-hour.

TABLE 4. Demand on Clinical Instructor Time Using Base Instructional Strategy Mixes for Foods and the Consumer Clinical Experience Units.

Clinical Experience Unit	Strategy Code*	Number of Students Per Class			
		10	15	20	25
		Hours Per Class			
Comparative Shopping	F_{11}	14.00	17.75	21.50	25.25
Mass Media	F_{21}	29.00	38.00	47.00	56.25
Information for Adults	F_{31}	16.50	21.50	26.50	31.50
Information for Children	F_{41}	16.50	21.50	26.50	31.50
Food advertising	F_{51}	14.00	16.50	19.00	21.50
Food Stamps	F_{61}	14.00	17.75	21.50	25.25
Menu Planning	F_{71}	13.00	16.75	20.50	24.25
Counseling	F_{81}	43.00	66.00	89.00	103.00
TOTAL		160.00	215.75	271.50	318.50
Average time per unit**		20.00	27.00	34.00	40.00
Average time per student**		16.00	14.50	13.50	12.50

*See Appendix C for instructional strategies.

**Rounded off to the nearest half-hour.

decrease of clinical instructor time required per student. Clinical instructor time per student decreased for the three courses approximately 10 hours from 49.4 for ten students to 39.1 hours for twenty-five students.

Basic nutrition. When the base strategy mixes were used for the nine clinical units the demand on clinical instructor time per student decreased as the size of the class increased. Clinical instructor time per student varied from 15.0 hours for a class of ten to 10.5 hours for a class of twenty-five (Table 2). Total clinical instructor time ranged from 148 to approximately 263 hours for ten to twenty-five students. Although total time increased as class size increased, the clinical instructor time required per student decreased because several of the strategy mixes included fixed elements. The clinical instructor time per unit increased as the size of the class increased from 16 to 29 hours for class sizes of ten to twenty-five students.

Nutrition and disease. When the base mixes were used for the six clinical units the demand on clinical instructor time per student decreased as the class size increased. Total time ranged from 186 hours for ten students to 397 hours for twenty-five students (Table 3). Clinical instructor time per student varied from 18.5 hours for a class of ten to 16.0 for a class of twenty-five students. The mean time required of clinical instructors for a unit increased as the size of the class increased. The mean time per clinical unit ranged from 31 hours for a class of ten to 66.2 hours for a class of twenty-five.

Foods and the consumer. For the eight clinical units required for foods and the consumer total demand on clinical instructor time ranged from 160 hours for a class of ten to approximately 319 hours for a class of twenty-five students (Table 4). Demand on clinical instructor time decreased per student as the size of the class increased. Clinical instructor time per student varied from 16 hours for a class of ten to 12.5 hours for a class of twenty-five. Fixed elemental times contributed to the decrease in clinical instructor time per student as the size of the class increased. The mean time required of clinical instructors for a clinical unit increased as the size of the class increased. The mean ranged from 20 hours for ten students to 40 hours for twenty-five.

Percent Distribution of Clinical Instructor Time

The percentage of clinical instructor time for major categories of teaching activities varied with a change in the class size (Table 5). An increase of class size resulted in a decrease in the percent of time devoted to planning and preparation and pre-experience activities. This decrease was due to planning being a fixed element as were the majority of the elemental times for preparation and pre-experience activities.

With only two exceptions, the percent of clinical instructor time devoted to supervision and grading and evaluation increased as the number of students increased. Supervisory elements were primarily ratio variables, and as such, clinical instructor time required to perform them would increase as the size of the class increased.

TABLE 5. Percent Distribution of Clinical Instructor Time Among Major Categories of Teaching Activities in Relation to Class Size for Base Instructional Strategy Mixes.

Teaching Activities	Distribution of Clinical Instructor Time — Number of Students Per Class: 10	15	20	25
	%	%	%	%
BASIC NUTRITION				
Planning	18.24	14.32	11.79	10.27
Preparation and Pre-experience	29.73	24.94	21.84	19.80
Supervision	14.19	18.17	20.74	20.93
Grading and Evaluation	37.84	42.57	45.63	49.00
NUTRITION AND DISEASE				
Planning	9.68	6.85	5.30	4.53
Preparation and Pre-experience	21.77	17.70	15.46	14.11
Supervision	31.72	36.82	39.62	39.17
Grading and Evaluation	36.83	38.63	39.62	42.19
FOODS AND THE CONSUMER				
Planning	15.00	11.12	8.84	7.54
Preparation and Pre-experience	27.19	24.57	22.47	21.35
Supervision	17.81	20.51	22.65	22.29
Grading and Evaluation	40.00	43.80	46.04	48.82

Likewise, the per student elemental times for grading and evaluation would increase the amount of total time devoted to performing these activities as the class size increased. The percent of clinical instructor time devoted to supervision of students for nutrition and disease and foods and the consumer when the class was composed of twenty-five students decreased slightly from the percent required for a class of twenty. Clinical instructors devoted 39.6 and 22.7 percent of their time to supervising experiences for nutrition and disease and foods and the consumer respectively for a class of twenty students. When the class size increased to twenty-five students 39.2 and 22.3 percent of clinical instructor time was devoted to supervision of nutrition and disease and foods and the consumer respectively. This decrease was a function of the ratio used for hospital visits. A class of twenty students would require seven clinical instructor visits to the clinical facility (Assumption 2, page 38) resulting in a clinical instructor to student ratio of less than 1:3. The eight visits required to supervise twenty-five students results in a ratio slightly greater than 1:3. Another contribution to the decrease of the percent of time required for supervision was the increased demand on clinical instructor time for per student variables such as grading and evaluation.

Commonalities of Base Instructional Strategy Mixes

Thirteen of the sixteen instructional strategies were used at least once in the base strategy mixes for the three clinical courses (Table 6). Audiotaped simulation, computer simulation, and self-paced modules were not used during this study. Twenty of the twenty-three

TABLE 6. Frequency of Instructional Strategies Used for Base Instructional Strategy Mixes for Three First Year Cinical Courses.

	Clinical Experience Units	
Instructional Strategies	Number Used*	Percent
Lecture	16	70
Group Discussion	16	70
Individual Discussion	9	39
Reading List	16	70
Computer Assisted Instruction	1	4
Videotaped Simulation	3	13
Audiotaped Simulation	-	-
Computer Simulation	-	-
Simulated Problem Level 1	2	9
Simulated Problem Level 2	2	9
Hospital Experience	6	26
Nonhospital Experience	11	48
Examinations	1	4
Written Assignment	20	87
Self-paced Module	-	-
Oral Presentation	1	4

*Total clinical experience units = 23.

clinical units required students to submit written assignments. Actual hospital experience was required for six of the units resulting in nine hospital visits per student. Although the number of hospital visits required per student appeared to be low when the competencies for the courses were considered, the number of visits were adequate. In addition to the nine hospital visits, three videotaped simulations and four simulated problems per student were presented to replace actual hospital experience. Eleven nonhospital experiences contributed to students attaining competencies required.

II. COMPETENCY CONTRIBUTIONS FOR BASE STRATEGY MIXES

On a five point scale, clinical instructors rated perceived competency contributions for each of the base strategy mixes (Questionnaire IV). A competency contribution rating of one indicated minimum contribution to desired competency and a rating of five indicated maximum contribution to competency. Approximately 13 percent of the base mixes were rated as five, 52 percent as four, 26 percent as three, and 9 percent as two. None of the base mixes were rated as one (Table 7). A competency contribution rating of 85 was obtained for the twenty-three base strategy mixes. A mean competency contribution per clinical unit was 3.7.

An adequate tool for measuring competency level attained by use of various instructional strategy mixes and to predict levels of attainment was not available. Competency contributions were perceived values of experienced clinical instructors. The development of such instruments was beyond the scope of this study. Literature findings

TABLE 7. Competency Contribution Ratings of Base Instructional Strategy Mixes for Three First Year Clinical Courses.

Course and Clinical Experience Unit*	Code**	Competency Contribution Rating
BASIC NUTRITION		33
Interviewing	N_{11}	4
Medical Records	N_{21}	4
Vitamins "n" Minerals	N_{31}	4
Maternal Nutrition	N_{41}	4
Infant and Child Nutrition	N_{51}	3
Adolescent Nutrition	N_{61}	3
Senescent Nutrition	N_{71}	3
Patient Counseling	N_{81}	4
Case Study	N_{91}	4
Average per unit		3.7
NUTRITION AND DISEASE		24
Interviewing and Counseling	D_{11}	4
Charting	D_{21}	4
Exchange Systems	D_{31}	3
Nutritional Assessment	D_{41}	4
Nutritional Care Plan	D_{51}	4
Case Study	D_{61}	5
Average per unit		4.0
FOODS AND THE CONSUMER		28
Comparative Shopping	F_{11}	3
Mass Media	F_{21}	4
Information for Adults	F_{31}	4
Information	F_{41}	3
Food Advertising	F_{51}	2
Food Stamps	F_{61}	2
Menu Planning	F_{71}	5
Counseling	F_{81}	5
Average per unit		3.5
AVERAGE PER JUNIOR YEAR		3.7

*Clinical experience units = 23.

**See Appendix C for instructional strategies.

indicated that students learn regardless of the instructional strategies used and that the major variable is the amount of time students need to master the subject matter (Block, 1971). However, instruction suited to a student's learning ability decreases time required.

Basic Nutrition

A course competency contribution rating of 33 was obtained for the nine base strategy mixes used for basic nutrition. A mean of 3.7 indicated that this course was the second most effective of the three courses. The clinical experiences for basic nutrition included five nonhospital experiences, (N_{31}; N_{41}; N_{51}; N_{61}; and N_{71}), two hospital experiences, N_{81} and N_{91}, a videotaped simulation, N_{11}, and a simulated problem, N_{21}. Other instructional strategies used in the mixes included lecture, individual and group discussions, and reading assignments.

Nutrition and Disease

A mean of 4 was obtained for the perceived competency contributions for the base mixes used for clinical units for nutrition and disease. The course competency contribution rating for the six units was 24. The base mixes used for nutrition and disease included five hospital visits per student, (D_{41}; D_{51}; and D_{61}), three simulated experiences, (D_{11}; D_{21}; and D_{31}), and a computer assisted instructional unit, D_{31}, lectures, individual and group discussions, and several reading assignments. Students visited the hospital two times each for the nutritional assessment and diet validation clinical unit and the clinical unit for nutritional care plans. The other visit was to

collect data to write a case study. Simulated experiences were for interviewing and counseling, D_{11}, recording in the medical chart, D_{21}, and menu planning using the exchange system, D_{31}. Clinical instructors rated the base strategy mixes for nutrition and disease as more effective, as far as attaining desired competency level than the mixes used for the other two clinical courses.

Foods and the Consumer

Clinical instructors rated the base mixes for foods and the consumer as the least effective. The mean for perceived competency contribution ratings was 3.5, the lowest value for the three courses. The course competency rating was 28.. Five clinical units used non-hospital experiences, (F_{11}; F_{31}; F_{41}; F_{51}; and F_{61}). The nonhospital experiences included visits to schools, the area's senior nutrition program, public assistance agencies, and a grocery store. Two hospital visits, F_{81}, focused on patient counseling. A Level 2 simulated problem, F_{71}, and a videotaped simulation, F_{21}, were required. Other instructional strategies used were lectures, individual and group discussions, and reading assignments.

III. ALTERNATIVE INSTRUCTIONAL STRATEGY MIXES

Forty-one instructional strategy mixes were identified as suitable alternatives for the base mixes (Questionnaire III). Demand on clinical instructor time was estimated for each alternative by application of elemental times for ten, fifteen, twenty, and twenty-five students (Questionnaire II). For each alternative, a competency

contribution rating was assigned (Questionnaire IV). Alternatives were identified for all clinical units but four (Tables 8, 9, 10).

Nine of the forty-one alternatives received a competency contribution rating of five. Twelve and fourteen were rated four and three, respectively. Six of the mixes were rated as two and none were rated as one. Ten of the alternatives had no effect on competency ratings; that is, the base and the alternatives for a clinical unit were rated the same by the panel. Of the ten alternatives, seven had a lower demand on clinical instructor time than the base strategy mix, one had the same time demand, and two placed a greater demand on clinical instructor time. Four of the alternatives for nutrition and disease had the same competency rating and a lower demand on clinical instructor time. One of the alternatives, D_{44}, required almost 41 hours less than the base mix for a class of fifteen students.

Approximately 68 percent of the alternatives had a competency rating equal to or greater than the competency rating given to the base strategy mix for the respective clinical experience unit. Eighteen or approximately 44 percent of the alternatives received competency ratings higher than their base mix. Ten alternatives were rated higher than their base mixes for basic nutrition, three for nutrition and disease, and five for foods and the consumer. Twelve of the eighteen alternatives with higher competency ratings had a higher demand on clinical instructor time for a class of fifteen students. Approximately 42 percent of the alternatives for basic

TABLE 8. Competency Contribution Ratings and Demand on Clinical Instructor Time for Base and Alternative Instructional Strategy Mixes for Basic Nutrition for Class to 25 Students.

Clinical Experience Unit	Code*	Competency Contribution Rating	Demand on Clinical Instructor Time			
			10 Students Hrs.	15 Students Hrs.	20 Students Hrs.	25 Students Hrs.
Interviewing	$**N_{11}$	4	24.50	29.75	35.00	40.50
	N_{12}	5	31.00	40.75	46.50	54.50
Medical Records	$**N_{21}$	4	15.50	18.00	20.50	23.00
	N_{22}	2	13.50	16.00	18.50	21.00
	N_{23}	3	16.00	18.50	21.00	23.50
	N_{24}	4	14.00	16.50	19.00	21.50
	N_{25}	5	14.50	17.00	19.50	22.00
Vitamins "n" Minerals	$**N_{31}$	4	15.00	17.50	20.00	22.50
	N_{32}	3	11.50	14.00	16.50	19.00
	N_{33}	2	11.50	14.00	16.50	19.00
	N_{34}	5	13.00	15.50	18.00	20.50
	N_{35}	3	11.50	14.00	16.50	19.00
Maternal Nutrition	$**N_{41}$	4	15.00	17.50	20.00	22.50
	N_{42}	4	12.00	14.50	17.00	19.50
Infant and Child Nutrition	$**N_{51}$	3	11.50	14.00	16.50	19.00
	N_{52}	4	12.00	14.50	17.00	19.50
Adolescent Nutrition	$**N_{61}$	3	11.50	14.00	16.50	19.00
	N_{62}	4	12.00	14.50	17.00	19.50
Senescent Nutrition	$**N_{71}$	3	7.00	8.25	9.50	10.75
	N_{72}	4	10.00	12.50	15.00	17.50
	N_{73}	3	7.00	7.00	7.00	7.00
	N_{74}	5	10.00	12.50	15.00	17.50
	N_{75}	4	12.00	14.50	17.00	19.50
Patient Counseling	$**N_{81}$	4	21.50	31.00	40.50	46.50
	N_{82}	5	23.00	33.00	42.50	49.00
Case Study	$**N_{91}$	4	26.50	38.50	50.50	59.00
	N_{92}	3	23.50	32.25	41.00	49.75
	N_{93}	5	33.00	48.00	62.50	74.00

*See Appendix C for instructional strategies.

**Base instructional strategy mix.

TABLE 9. Competency Contribution Ratings and Demand on Clinical Instructor Time for Base and Alternative Instructional Strategy Mixes for Nutrition and Disease for Class Size of 10 to 25 Students.

Clinical Experience Unit	Code*	Competency Contribution Rating	Demand on Clinical Instructor Time: 10 Students Hrs.	15 Students Hrs.	20 Students Hrs.	25 Students Hrs.
Interviewing and Counseling	**D_{11}	4	29.00	36.75	44.50	52.50
	D_{12}	3	23.50	32.75	40.00	47.50
	D_{13}	5	36.00	50.25	64.50	75.50
Charting	**D_{21}	4	16.00	19.75	23.50	27.25
	D_{22}	2	19.50	27.75	36.00	40.75
	D_{23}	4	23.00	29.25	35.50	41.75
	D_{24}	5	28.00	39.75	51.50	59.25
Exchange Systems	**D_{31}	3	24.50	30.75	37.00	43.75
	D_{32}	3	21.00	27.25	33.50	39.75
	D_{33}	5	31.50	44.75	58.00	67.75
	D_{34}	2	17.50	21.25	26.00	29.75
	D_{35}	3	20.00	25.00	31.00	36.00
Nutritional Assessment	**D_{41}	4	40.00	61.00	82.00	95.00
	D_{42}	3	28.00	39.25	50.00	57.75
	D_{43}	4	32.00	45.75	59.00	69.25
	D_{44}	3	16.50	20.25	24.00	27.75
Nutritional Care Plant	**D_{51}	4	42.50	64.75	87.00	101.25
Case Study	**D_{61}	5	34.00	49.75	65.50	77.75
	D_{62}	4	26.50	38.50	50.50	59.00

*See Appendix C for instructional strategies.

**Base strategy mix.

TABLE 10. Competency Contribution Ratings and Demand on Clinical Instructor Time for Base and Alternative Instructional Strategy Mixes for Foods and the Consumer for Class Sizes of 10 to 25 Students.

Clinical Experience Unit	Code*	Competency Contribution Rating	Demand on Clinical Instructor Time			
			10 Students Hrs.	15 Students Hrs.	20 Students Hrs.	25 Students Hrs.
Comparative Shopping	**F_{11}	3	14.00	17.75	21.50	25.25
	F_{12}	4	11.50	14.00	16.50	19.00
Mass Media	**F_{21}	4	29.00	38.00	47.00	56.25
Information for Adults	**F_{31}	4	16.50	21.50	26.50	31.50
	F_{32}	4	11.50	14.00	16.50	19.00
	F_{33}	2	11.50	14.00	16.50	19.00
Information for Children	**F_{41}	3	16.50	21.50	26.50	31.50
	F_{42}	3	19.00	25.25	31.50	37.75
Food Advertising	**F_{51}	2	14.00	16.50	19.00	21.50
	F_{52}	2	14.00	16.50	19.00	21.50
	F_{53}	3	14.00	16.50	19.00	21.50
Food Stamps	**F_{61}	2	14.00	17.75	21.50	25.25
	F_{62}	3	14.00	17.75	21.50	25.25
	F_{63}	3	9.50	12.00	14.50	17.00
	F_{64}	4	8.50	11.00	13.50	16.00
Menu Planning	**F_{71}	5	13.00	16.75	20.50	24.25
Counseling	**F_{81}	5	43.00	66.00	89.00	103.00

*See Appendix C for instructional strategies.

**Base instructional strategy mix.

nutrition had higher demands on clinical instructor time and a higher competency rating than their base strategy mixes. This relationship was found for one-third of the alternatives for nutrition and disease. None of the five alternatives that received higher competency ratings than their base mixes had a greater demand on clinical instructor time for the foods and the consumer course. Three of the alternatives had a lower demand on clinical instructor time and two had no effect on clinical instructor time. From these findings it appeared that the competency rating for foods and the consumer could be increased with a decreased demand on clinical instructor time. Exit interviews held with graduating seniors over the past few years have indicated that foods and the consumer clinical experiences were the least effective in terms of what the students gained in relation to the amount of time devoted to the course by the students. It also appears from the findings of this study that returns on clinical instructor time for the course were minimal.

Approximately 56 percent of the alternatives when compared to their respective base strategy mixes required less clinical instructor time. Persons responsible for selecting instructional strategy mixes from the pool of base and alternative mixes should use some systematic technique to aid in the decision making process especially when their objective is to maximize competency contribution of strategy mixes used and not exceed available clinical instructor time. Linear programming and a heuristic model were used to select instructional strategy mixes from the pool of sixty-four base and alternative mixes for the coordinated dietetic program.

IV. APPLICATION OF MAXIMIZING TECHNIQUES

Four sets of problems were formulated to optimize use of clinical instructor time while increasing competency rating of instructional strategy mixes used for junior year clinical courses. Each problem set represented one of four class sizes. Solutions generated by the Clinical Instructor Decision Model (CIDMO) and the Heuristic Routine for Selecting Instructional Strategy Mixes (HRSISM) for the problem sets were compared to base strategy mixes or mixes giving minimum or maximum competency rating. Comparisons were made to ascertain differences in the demands on clinical instructor time, competency contribution ratings, and the amounts of slack time generated. The instructional strategy mixes included in the CIDMO and HRSISM solutions were compared to base strategy mixes, strategy mixes giving minimum competency rating, and strategy mixes giving maximum competency rating to identify differences in the instructional strategies used in the mixes for a clinical experience unit.

Problem Set 1

This problem set was designed for a class of ten students with the objective of improving the perceived competency contribution rating of strategy mixes used when staffing levels were equivalent to the number of clinical instructor positions required for minimum competency and base strategy mixes. Instructional strategy mixes meeting minimum competency, base competency, and maximum competency could be achieved with the same staffing level (Table 11). A clinical

TABLE 11. Comparison of Competency Values (CV) in Relation to Demand on Clinical Instructor (CI) Time for 10 Students.

Course Name	Number Required Clinical Units	Base Solution C.V.	Base Solution C.I. Time Hrs.	Minimum CV Solution C.V.	Minimum CV Solution C.I. Time Hrs.	Minimum CV Solution Number of Units With Changed ISM*	Maximum CV Solution C.V.	Maximum CV Solution C.I. Time Hrs.	Maximum CV Solution Number of Units With Changed ISM*	CIDMO and HRSISM Solutions[y] C.V.	CIDMO and HRSISM Solutions[y] C.I. Time Hrs.	CIDMO and HRSISM Solutions[y] Number of Units with Changed ISM*
Basic Nutrition	9	33	148.0	28	136.5	5	42	160.5	9	42	160.5	9
Nutrition and Disease	6	24	186.0	18	146.0	5	28	204.0	4	28	204.0	4
Foods and the Consumer	8	28	160.0	26	155.0	1	32	147.0	4	32	147.0	4
TOTAL C.V.		85		72			102			102		
Minimal Required C.I. Positions			0.75**		0.75**			0.75**			0.75**	

*ISM: Instructional Strategy Mix

**0.75 C.I. Positions: Available C.I. time = 220 hours per course

[y]CIDMO and HRSISM Solutions = maximum CV solutions

instructor hired on a three-quarter time basis provided sufficient time to use the strategy mixes that gave a competency contribution rating of 102, the maximum for the twenty-three clinical experience units.

By selecting the instructional strategy mixes producing maximum competency, a 20 percent increase of competency contribution ratings above the base mix could be achieved with only a 3.5 percent increase in the demand on clinical instructor time. When the instructional strategy mixes that gave maximum competency ratings were used with a three-quarter time clinical instructor 148.5 slack hours resulted compared to 166 slack hours for the base strategy mixes. Seventeen of the alternatives replaced base mixes for the three courses.

Problem Set 2

This set of problems was designed with the same objective as Problem Set 1, except for the number of students. Fifteen students rather than ten students were considered as a class. Based on clinical instructor time required for base mixes and to meet minimum competency contribution ratings, it was possible to staff at two levels, a three-quarter time or a full-time clinical instructor (Table 12). Since a full-time clinical instructor allowed for maximum competency, it was only necessary to apply CIDMO and HRSISM for a three-quarter time clinical instructor.

Maximum competency contribution ratings were possible for clinical units required for basic nutrition and foods and the

TABLE 12. Comparison of Competency Values (CV) in Relation to Demand on Clinical Instructor (CI) Time for 15 Students.

Course Name	Number Required Clinical Units	Base Solution		Minimum CV Solution			Maximum CV Solution			CIDMO and HRSISM Solutions[y]		
		C.V.	C.I. Time Hrs.	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*
Basic Nutrition	9	33	188.5	28	172.5	5	42	210.25	9	42	210.25	9
Nutrition and Disease	6	24	262.75	18	205.25	5	28	295.0	4	23	216.25	2
Foods and the Consumer	8	28	215.75	26	208.25	1	32	197.25	4	32	197.25	4
TOTAL C.V.		85		72			102			97		
Minimal Required C.I. Positions			1.0**		0.75***			1.0**			0.75***	

*ISM: Instructional Strategy Mix

**1.0 C.I. Positions: Available C.I. time = 320 hours per course

***0.75 C.I. Positions: Available C.I. Time = 220 hours per course

[y]CIDMO and HRSISM Solutions = maximum CV solutions

consumer with a three-quarter time clinical instructor. CIDMO and HRSISM was applied to nutrition and disease.

Nutrition and disease. A competency contribution rating of 23, five points higher than minimum and one point less than the base was obtained for CIDMO and HRSISM solutions with a three-quarter time clinical instructor. Demand on clinical instructor time for solutions generated by the maximizing techniques was 5.4 percent greater than time required for minimum competency and 46.5 hours or 17.7 percent less than base requirements. Demand on clinical instructor time per student increased by 0.7 hours, while demand per clinical experience unit increased by 1.8 hours for the CIDMO and HRSISM solutions over demands required for minimum competency. The demand on clinical instructor time for CIDMO and HRSISM solutions per student and per clinical unit was approximately 3.0 and 7.75 hours less than base demands, respectively. The base mixes generated approximately 15.3 times as much slack as did CIDMO and HRSISM solutions. However, the base slack was for a full-time clinical instructor while CIDMO and HRSISM was for a three-quarter time clinical instructor.

Optimal feasible solution. The optimal feasible solution for Problem Set 2 with a three-quarter time clinical instructor position available included strategy mixes that gave maximum competency for basic nutrition and foods and the consumer and the CIDMO and HRSISM solutions for nutrition and disease. The optimal feasible solution gave a competency contribution rating 34.7 percent higher than minimum competency contribution rating and 14.1 percent higher than

base mixes. The competency rating for a three-quarter time clinical instructor was only five points less than potential maximum rating. Demand on clinical instructor time per clinical experience unit was 1.9 hours less than base demand and 1.6 hours greater than demand for strategy mixes giving minimum competency rating. Slack time generated for optimal feasible solution was approximately one-half of that generated when minimum strategy mixes were used and one-eighth of the slack generated for base strategy mixes.

Problem Set 3

For a class of twenty students, two staffing levels were possible, a full-time clinical instructor or 1.5 clinical instructor positions (Table 13). The 1.5 clinical instructor positions were assumed to be one full-time and one half-time clinical instructors. The reason that the positions were not filled totally by part-time clinical instructors was that a full-time clinical instructor would provide more continuity of the program over time. The investigator believed that full-time clinical instructors are more likely to remain with the program for a longer period of time than part-time instructors.

A full-time clinical instructor position provided enough time to employ instructional strategy mixes contributing to maximum competency for clinical units required for basic nutrition and foods and the consumer with a class of twenty students. The maximizing techniques were applied to nutrition and disease with one full-time clinical instructor for twenty students.

TABLE 13. Comparison of Competency Values (CV) in Relation to Demand on Clinical Instructor (CI) Time for 20 Students.

		Base Solutions		Minimum CV Solutions			Maximum CV Solutions			CIDMO and HRSISM Solutions[y]		
Course Name	Number Required Clinical Units	C.V.	C.I. Time Hrs.	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units With Changed ISM*
Basic Nutrition	9	33	229.0	28	208.5	5	42	255.0	9	42	255.0	9
Nutrition and Disease	6	24	339.5	18	263.5	5	28	385.5	4	25	302.5	2
Foods and the Consumer	8	28	271.5	26	261.5	1	32	248.5	4	32	248.5	4
TOTAL CV		85		72			102			99		
Minimal Required C.I. Positions			1.5**		1.0***			1.5**			1.0***	

*ISM: Instructional Strategy Mix

**1.5 C.I. Positions: Available C.I. time = 440 hours per course

***1.0 C.I. Positions: Available C.I. time = 320 hours per course

[y]CIDMO and HRSISM Solutions for 1.5 C.I. positions are the same as maximum CV solution

Nutrition and disease. The competency contribution rating for nutrition and disease was increased by seven points above minimum competency and one point above base competency rating when CIDMO and HRSISM were applied to select strategy mixes. The increase in competency contribution rating above minimum was accomplished by substituting four instructional strategy mixes, D_{11}, D_{21}, D_{33}, and D_{61} for strategy mixes giving minimum competency (Appendix D). With the exception of D_{33}, the changes replaced strategy mixes giving minimum competency with base strategy mixes. The changes increased demand on clinical instructor time by 39 hours or 14.8 percent above time required for minimum competency.

When the solutions generated by CIDMO and HRSISM were compared to base strategy mixes there were two changes from the base mix. Instead of using the base mixes for the exchange systems unit, D_{31}, and the nutritional assessment and validation unit, D_{41}, alternative mixes, D_{33} and D_{44}, were used respectively. The net effect of the changes from the base mixes increased competency contribution rating by one point and decreased demand on clinical instructor time by 37 hours or 10.9 percent.

Optimal feasible solution. The optimal feasible solution for Problem Set 3 when a full-time clinical instructor position was available for twenty students included strategy mixes that gave maximum competency for basic nutrition and foods and the consumer and strategy mixes in the CIDMO and HRSISM solutions for nutrition and disease. Total competency rating was 99, three points less than maximum when

1.5 clinical instructors were available. The competency rating obtained for the optimal feasible solution was 37.5 percent greater than minimum competency and 16.5 percent greater than base competency. These increases were accomplished with a 9.9 percent increase in the amount of clinical instructor time required for minimum competency and a 4.0 percent decrease of instructor time for base strategy mixes. Slack time decreased to 154 hours for the optimal feasible solution. Base slack time was slightly more than three times this amount and slack time for minimum competency was nearly 1.5 times greater. However, the amount of slack time generated for base strategy mixes was for 1.5 clinical instructor positions.

Problem Set 4

It was possible to staff for a class of twenty-five students with one full-time clinical instructor position, 1.5 clinical instructor positions, or 1.75 clinical instructor positions (Table 14). One full-time clinical instructor position was sufficient to achieve maximum competency levels for clinical units required for basic nutrition and foods and the consumer. Maximum competency rating for nutrition and disease was not possible with one clinical instructor or 1.5 clinical instructor positions for twenty-five students. CIDMO and HRSISM were applied to nutrition and disease for one clinical instructor position and 1.5 clinical instructor positions.

Nutrition and disease. When the maximizing techniques were applied to nutrition and disease for one clinical instructor position

TABLE 14. Comparison of Competency Values (CV) in Relation to Demand on Clinical Instructor (CI) Time for 25 Students.

Course Name	Number Required Clinical Units	Base Solution		Minimum CV Solution			Maximum CV Solution			CIDMO and HRSISM Solutions[y]			CIDMO and HRSISM Solutions		
		C.V.	C.I. Time Hrs.	C.V.	C.I. Time Hrs.	Number of Units with Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units with Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units with Changed ISM*	C.V.	C.I. Time Hrs.	Number of Units with Changed ISM*
Basic Nutrition	9	33	262.75	28	241.25	5	42	296.0	9	42	296.0	9	42	296.0	9
Nutrition and Disease	6	24	397.0	18	306.0	5	28	450.75	4	22	303.75	3	27	409.25	4
Foods and the Consumer	8	28	318.5	26	306.0	3	32	290.5	4	32	290.50	4	32	290.5	4
TOTAL CV		85		72			102			96			101		
Minimal Required C.I. Positions			1.5**		1.0***			1.75****			1.0***			1.5	

*ISM: Instructional Strategy Mix

**1.5 C.I. Positions: Available C.I. time = 440 hours

***1.0 C.I. Positions: Available C.I. time = 320 hours

****1.75 C.I. Positions: Available C.I. time = 540 hours

[y] CIDMO and HRSISM Solutions for 1.75 C.I. Positions = the same as maximum CV solution

a competency contribution rating of 22, an increase of four points above minimum competency and a decrease of two points from base competency was attained. To achieve the competency contribution rating of 22, three changes from minimum competency strategy mixes were required. Strategy mixes; D_{11}, D_{21}, and D_{35}, replaced the strategy mixes giving minimum competency for their respective clinical units (Appendix D). The changes decreased demand on clinical instructor time by 2.25 hours.

Three changes were made from the base strategy mixes when one clinical instructor position was used for twenty-five students. Strategy mixes; D_{35}, D_{44}, and D_{62}, replaced their respective base mixes. The changes for the three clinical units from base mixes to the alternatives resulted in a decreased demand on clinical instructor time by approximately 93 hours or 23.6 percent and a two point decrease in competency contribution rating.

A competency contribution rating of 27 was attained for nutrition and disease when CIDMO and HRSISM were applied for 1.5 clinical instructor positions. Four base strategy mixes were replaced by D_{13}, D_{24}, D_{33}, and D_{44} to attain this competency rating. These changes resulted in a three point increase in competency contribution rating and an increased demand on clinical instructor time per student and per clinical unit of 0.5 hours and 2.0 hours, respectively.

<u>Optimal feasible solutions.</u> Two optimal feasible solutions were obtained for Problem Set 4 based on staffing levels. The

optimal feasible solutions differed in the strategy mixes used for nutrition and disease. Strategy mixes for nutrition and disease were determined by application of CIDMO and HRSISM for one clinical instructor position and 1.5 clinical instructor positions. Maximum competency strategy mixes were used for both basic nutrition and foods and the consumer.

Competency contribution rating for the optimal feasible solution for one clinical instructor position was 96, an increase of 33 percent and 13 percent respectively above minimum and base competency ratings. Demand on clinical instructor time was 35.6 hours per student and 38.7 hours per clinical unit. Demand on clinical instructor time was greater than time demand for minimum competency strategy mixes and less than demand for base strategy mixes. The amount of slcak time generated for the optimal feasible solution using a full-time clinical instructor for a class of twenty-five students was 65.34 percent and 20.4 percent of the amounts generated for minimum competency strategy mixes and base mixes respectively.

Competency contribution rating for the optimal feasible solution for 1.5 clinical instructor positions was 101, an increase of approximately 19 percent over the base rating, and only one point below maximum competency. Demand on clinical instructor time increased by 17.5 hours or 1.8 percent over base demand. The optimal feasible solution for 1.5 clinical instructor positions generated more than 4.6 times the slack generated for the optimal feasible solution for one clinical instructor position.

Consideration of Slack Time

Before deciding to teach each course at its maximum competency contribution level, persons responsible for such decisions, must be aware of the increasing percent of available clinical instructor time not used for the clinical units as the number of students increase (Table 15). The amount of slack time increased more than 3.9 times as the size of the class increased from ten students to twenty-five students when staffing levels were established to allow use of instructional strategy mixes that contributed to maximum competency and the number of positions staffed were the same for each academic quarter. The increases in slack time were attributed to staffing at a level each quarter that allowed for maximum competency rating for nutrition and disease, the course with the greatest demand on clinical instructor time. It was possible to attain maximum competency rating for basic nutrition and foods and the consumer for a class of fifteen students with a three-quarter time clinical instructor, while a full-time clinical instructor position was needed for nutrition and disease for the same class size. This discrepancy between nutrition and disease and the other two courses was greater as the size of the class increased. Maximum competency for basic nutrition and foods and the consumer for class sizes of twenty and twenty-five students was achieved with one clinical instructor position, while nutrition and disease required 1.5 and 1.75 clinical instructor positions for twenty and twenty-five students, respectively.

TABLE 15. Competency Contribution Ratings and Slack Time for Base, Optimal Feasible, and Maximum Solutions Based on Available Clinical Instructor (CI) Time and Number of First Year Students for a Coordinated Dietetic Program.

Size	Competency Contribution Rating	Available CI Time	Slack Time	Slack
(Students)		(Hours)	(Hours)	(Percent)
10	102*	660	148.5	22.5
10	85**	660	166.0	25.2
15	97***	660	36.3	5.5
15	102*	960	257.5	26.8
15	85**	960	293.0	30.5
20	99***	960	154.0	16.0
20	102*	1320	431.0	32.7
20	85**	1320	480.0	36.4
25	96***	960	69.8	7.3
25	101***	1320	324.3	24.6
25	85**	1320	341.8	25.9
25	102*	1620	582.8	36.0

*Maximum competency rating

**Base competency rating

***Optimal feasible solution competency rating

Comparison of Selected Strategy Mixes

Fifty-one instructional strategy mixes were included as base strategy mixes, mixes contributing to minimum or maximum competency, or mixes used for CIDMO and HRSISM solutions for the problem sets. Twenty-three of the mixes were base strategy mixes. Eleven of the base mixes were replaced by alternatives for minimum competency rating and seventeen were replaced for maximum competency rating. The solutions for base strategy mixes, minimum competency strategy mixes, maximum competency strategy mixes, and strategy mixes included for CIDMO and HRSISM applications were identified and differences in the solutions noted (Appendix D). Each alternative strategy mix that was included in a solution was compared to the base mix for the clinical experience unit to identify changes from the base mix.

Basic nutrition. Five alternatives replaced base strategy mixes for minimum competency rating and all nine base mixes were replaced for maximum competency rating. The five alternatives for minimum competency rating were: N_{22}; N_{33}; N_{42}; N_{73}; and N_{92}. Strategy mix, N_{22}, replaced the base mix for the medical records unit. The differences between N_{22} and the base mix were the addition of a simulated problem and the elimination of an individual conference at the conclusion of the experience unit. For the vitamins "n" minerals unit, strategy mix, N_{33}, differed from N_{31} by the elimination of the post-experience conference. The maternal nutrition unit alternative mix, N_{42}, differed from the base mix in two ways. Strategy mix, N_{42}, did not include a guest speaker and

the post-experience conference was a group sharing of experiences limited to one-half hour. For the clinical unit on senescent nutrition, the major difference between N_{71} and N_{73} were the addition of a post-experience group discussion and the elimination of the written assignment. The only major difference between strategy mixes for the case study unit was that strategy mix, N_{92}, required students to give an oral presentation.

To achieve maximum competency rating all of the base strategy mixes were replaced. Strategy mix, N_{12}, replaced the base mix for the interviewing unit. Strategy mix, N_{12}, included an audiotaped simulation followed by individual conferences and a videotaped simulation. The videotaped simulation was critiqued and summarized by group discussion. The major differences between the base mix and the alternative mix for the medical records unit were that strategy mix, N_{25}, required the completion of a reading list and a self-paced module. The difference between the base mix and the alternative mix for the vitamins "n" minerals unit was in the manner in which the post-experience conference was conducted. Strategy mix, N_{34}, limited the conference to one-half hour of sharing experiences rather than the clinical instructor preparing a summary of the student's findings. Likewise, the maternal nutrition unit replacement, N_{42}, included a post-experience conference for sharing experiences limited to one-half hour. The unit for infant and child nutrition was essentially the same for strategy mixes, N_{51} and N_{52}, except N_{52} included a group discussion in which students shared experiences. The same was true for the unit on adolescent

nutrition, strategy mixes, N_{61} and N_{62}. For the clinical unit on senescent nutrition, the major differences between strategy mixes, N_{71} and N_{74}, were in the method of grading and the inclusion of a group discussion in which students shared experiences. Strategy mix, N_{74}, required students to submit a written report, whereas, students were only required to make logbook notations for strategy mix, N_{71}. The instructional strategy mixes for patient counseling were essentially the same for N_{81} and N_{82}. Strategy mix, N_{82}, included a post-experience conference in the clinical facility and a group discussion at the next class meeting in which students shared experiences. Strategy mixes for the case study unit differed in two ways. For N_{93}, clinical instructors were required to supervise the students and conduct a group sharing experience at the completion of the unit and were responsible for evaluating students' presentations. For mix, N_{91}, the students were supervised by clinical facility personnel and no sharing of experience was included.

Nutrition and disease. Ten alternatives were used as replacements for the six base strategy mixes for the problem sets to obtain minimum or maximum competency rating, or as part of CIDMO and HRSISM solutions. Five of the alternatives were for minimum competency rating, four for maximum competency rating, and one for CIDMO and HRSISM solutions. The five strategy mixes replacing base mixes for minimum competency were: D_{12}; D_{22}; D_{34}; D_{42}; and D_{62}. The alternative mix, D_{12}, for the interviewing and counseling unit, did not require a pre-experience lecture on skills and techniques of effective interviewing and counseling. This

strategy mix required individual post-experience conferences. The major difference between the base mix for the charting unit and strategy mix, D_{22}, was the replacement of the simulated problem with actual hospital experience. For the unit on the exchange systems, the major differences between the base mix and D_{34} were elimination of the post-experience examination and of the written assignment. Strategy mix, D_{44}, replaced the base mix for the nutritional assessment unit. There were three differences between the base mix and D_{44}. The alternative mix did not require a group discussion or actual hospital experience. Strategy mix, D_{44}, required students to complete a simulated problem. For the case study unit, D_{62} differed from the base mix in two ways. Strategy mix, D_{62}, did not require students to give an oral presentation of the case study. Consequently, there was not a need for individual discussion following the presentation.

Strategy mixes, D_{13}, D_{24}, D_{33}, and D_{43} replaced base mixes when maximum competency strategy mixes were used. D_{13}, an alternative mix for the interviewing and counseling unit, required individual rather than group critique of the videotaped simulation followed by an actual hospital visit. The major difference between the base mix for the charting unit and strategy mix, D_{24}, was the addition of a hospital visit following the simulated problem. Strategy mix, D_{33}, for the exchange systems unit, required a workshop on the exchange systems. The workshop replaced the CAI module with simulated experiences and did not require a written assignment. For the nutritional assessment unit, strategy mix, D_{43}, differed from the

base mix by the addition of individual post-experience conferences and the completion of a simulated problem.

Strategy mix, D_{35}, was the only altervative that was included in a CIDMO or HRSISM solution that was not a base, minimum competency, or maximum competency strategy mix. Strategy mix, D_{35}, differed from the base mix by not requiring group discussion, inidividual discussion, or a written assignment.

Foods and the consumer. In addition to the eight base strategy mixes, five alternatives were used for foods and the consumer. One alternative was used for minimum competency rating and four for maximum competency rating. No additional strategy mixes were required for CIDMO and HRSISM solutions. The one alternative used for minimum competency was for the unit on information for adults. Two significant changes were noted between F_{31} and F_{33}, the alternative mix. Strategy mix, F_{33}, did not require the clinical instructor to attend student presentations and students were to submit written reports for the unit.

The four alternatives used for maximum competency were: F_{12}; F_{32}; F_{53}; and F_{64}. For the unit on comparative shopping, there were two major differences between the base mix and F_{12}. The alternative mix did not require a pre-experience lecture or a post-experience individual conference. The only difference between F_{31} and F_{32}, strategy mixes for the unit information for adults, was that the clinical instructor did not attend the students' presentations. Supervision for this activity was the responsibility of the facility personnel. For the unit on advertising, the major

difference between F_{51} and F_{53} was when the experience was scheduled. For the replacement strategy mix students were to complete the unit simultaneously with a similar assignment in the didactic course. Because of the specificity of scheduling, the clinical instructors rated the competency contribution for the mix higher when completed as F_{53}. The major difference between F_{61} and F_{64} was that for the latter the clinical instructor met with the students individually to assist with developing a presentation for the food stamps experience. A post-conference was held with each student following the experience. The replacement mix did not require clinical instructors to lead a group discussion on food stamps or grade written assignments submitted by students.

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY

I. CONCLUSIONS

Demand on clinical instructor time was estimated by use of elemental times for various instructional strategy mixes. The elemental times provided reliable input for a data base when determining resource needs for a dietetic program. Two types of elemental times were identified in this study, fixed and variable. Fixed elemental times were for those teaching activities for which demand on clinical instructors' time to perform the instructional strategy did not change with a change in the class size. All clinical experience units had at least one fixed element, planning.

Variable elemental times were of two types, per student variables and ratio variables. Per student variables tended to have a stronger effect on total clinical instructor time required for an instructional strategy mix when the size of the class increased. For each additional student included there was an equal increase in the demand on clinical instructor time, whereas, for ratio variables, the increase in the demand on clinical instructor time was a function of the number of students added to the class and the upper bounds of the instructor student ratio for the instructional strategies involved. Larger class sizes placed greater demand on clinical instructor time for performing grading and evaluation activities. These activities were primarily

per student variables. Time needed for grading and evaluation reduced time available for supervision. Because of the amount of time needed for grading and evaluation more clinical instructor positions were needed to provide adequate supervision for larger class sizes.

Findings of this study suggest that when competency contribution ratings are systematically assigned to instructional strategy mixes, the ratings become effective discriminators for selecting strategy mixes for clinical experience units. The competency contribution ratings were part of the data base used for determining resource needs of CUP.

The number of alternative instructional strategy mixes identified by panels of clinical instructors, students, and clinical facility personnel and the competency contribution ratings of the alternatives indicated that use of such panels to generate strategy mixes for clinical units was effective. Including students and clinical facility personnel in the process of identifying feasible instructional strategy mixes increased the number of alternatives identified for most of the clinical experience units. The perceived competency contribution ratings for slightly more than 68 percent of the alternatives were equal to or greater than ratings for their respective base strategy mixes.

The data indicated that application of a computerized or manually manipulated scheme to maximize competency contribution ratings for a course was an effective aid for the efficient use of available resource. To function effectively, the maximizing scheme

required two data bases, the demand on clinical instructor time for each instructional strategy mix and the competency contribution rating of the strategy mixes.

Elemental times established for teaching activities for instructional strategy mixes provided quantitative data for decisions related to allocation of resources in a dietetic program. Analysis of elemental times and time estimates for instructional strategy mixes derived from such times were the basis for the use of linear programming and the heuristic model. The techniques were equally effective in generating solutions to optimize use of available clinical instructor time while maximizing competency contribution ratings of strategy mixes used. Linear programming techniques gave solutions with higher competency contribution ratings than base mixes when the same amount of clinical instructor time was available.

Clinical experiences for nutrition and disease placed the greatest demand on clinical instructor time. It was possible to offer clinical experiences for basic nutrition and for foods and the consumer at the maximum competency levels for twenty-five students with one clinical instructor position, whereas, maximum competency for nutrition and disease could only be offered for fifteen students at this staffing level. To offer nutrition and disease at maximum competency for twenty-five students required 1.75 clinical instructor positions. To staff based on a policy that the same number of clinical instructor positions would be filled each academic quarter created increasing amounts of slack time as the class size increased. The majority of slack time generated by such a policy occurred for

basic nutrition and foods and the consumer. Since nutrition and disease was the course determining the amount of staff needed the amount of slack time for this course was minimal.

II. RECOMMENDATIONS

Coordinated dietetic program faculty should use some type of procedure to increase the potential selection of strategy mixes that give maximum competency contribution without violating resource limitations. Since CIDMO and HRSISM generated solutions that included strategy mixes that gave higher competency ratings than the base mixes, strategy mixes currently used by the program, the use of such techniques would be valuable as a resource allocation model for program administrators. Further refinements of elemental times required for the dietetic program should include the second year of the professional phase, as well as the demands on student and clinical facility personnel time. Data obtained in such a study should be applied in a multiple constraint model with limited clinical instructor, student, and clinical facility personnel time.

The clinical experiences for nutrition and disease need to be evaluated to ascertain the reasons why time demands for these experiences are out of line with the other courses. The clinical units for nutrition and disease should be evaluated to determine whether the expected competency level for the course is realistic for first year students and the amount of clinical instructor, student, and clinical facility personnel time available. If the present competency level is appropriate, better use of clinical instructor time could be achieved

by rearranging clinical experiences required for the first year. This is even more important when one considers students' comments about nutrition and disease and foods and the consumer over the past few years. The comments have centered on the fact that nutrition and disease is very important and that the time frame allotted for mastery of the concepts and skills is too short. Whereas, the time allotted for foods and the consumer is more than sufficient for the contents of the course.

Data bases must be developed in order for coordinated dietetic programs to use such techniques as CIDMO and HRSISM. Elemental times of teaching activities for instructional strategies used by CUP's must be continuously evaluated. Logbook notations by clinical instructors could be used to estimate use of clinical instructor time for teaching activities. Work sampling could be effective in determining percent of time spent in indirect teaching activities.

Due to the concerns of administrators over the cost of a coordinated dietetic program micromodels of such programs should be developed to study the effects of variable levels of funding on the quality of the program. Application of CIDMO or HRSISM could be used to simulate such situations.

Further research is needed to ascertain the effectiveness of various mixes of instructional strategies and the relationship between competency levels attained by students and the amount of clinical instructor time required as well as student time.

III. SUMMARY

Elemental times for clinical instructor demands and perceived competency contribution ratings for instructional strategy mixes formed data bases for the dietetic program. The data bases were validated and used to study interrelationships of class size, available clinical instructor time, and competency rating on the selection of instructional strategy mixes. The data bases were developed in the following manner.

The objective of each clinical unit required for first year professional courses was identified. Instructional strategies used to meet the objectives were identified as well as potential alternative strategies. Four questionnaires were developed to identify instructional strategy mixes currently used for the clinical experience units, estimate elemental times, identify alternative strategy mixes, and rate each strategy mix for competency contribution. A training session was held to pilot test the questionnaires and to familiarize the panelists with the objectives of the study.

Panels consisting of a clinical instructor, three students, and a clinical facility representative verified the instructional strategies used during the base period for each clinical unit by completing Questionnaire I. Clinical instructors completed Questionnaire II to establish elemental times for teaching activities for various instructional strategies for a class of fifteen students. Following completion of Questionnaire II, the elemental times were applied to the base strategy mixes for a class of fifteen students.

Time estimates for base strategy mixes were validated by a panel of clinical instructors by consensus.

The panels that completed Questionnaire I for a clinical unit identified alternative strategy mixes by completing Questionnaire III. Alternatives that a consensus of the panel thought were suitable replacements for the base strategy mixes were included in the strategy pool. Time estimates were determined and validated for the alternatives in the same manner as for the base mixes. Using elemental times for a class of fifteen students, clinical instructors estimated elemental times for class sizes of ten, twenty, and twenty-five students. The elemental times for these class sizes were used to determine time estimates for each strategy mix in the strategy pool.

Clinical instructors completed Questionnaire IV by estimating the competency contribution of strategy mixes on a five point scale, with one indicating the lowest contribution and five the highest contribution to competency. Perceived competency contribution ratings were established by consensus of clinical instructors.

Analysis of data was by comparison of the solutions of the integer linear programming model (Clinical Instructor Decision Model), the Heuristic Routine for Selecting Instructional Strategy Mixes (HRSISM), and the base instructional strategy mixes for perceived course competency contributions and demand on clinical instructor time. Comparisons were made for four class sizes with varying levels of available clinical instructor time.

Time estimates for a strategy mix were directly related to the number of students enrolled in a course. Demand on clinical instructor

time increased per clinical unit as the size of the class increased. Demand on clinical instructor time per student decreased as the size of the class increased. Demand on clinical instructor time per student and per clinical unit varied with the amount of clinical time available for the problems formulated. Course competency contribution ratings were consistently higher for the CIDMO and HRSISM solutions than for the base strategy mixes for the same amount or less of available clinical instructor time.

The methodology developed was effective for establishing elemental times of teaching activities for instructional strategies and studying the effects of time estimates of strategy mixes on the potential competency of students. Future research should consider demand on student time and clinical facility personnel time for the two years of the professional phase of CUP. Demand on clinical instructor time for indirect teaching activities should be studied to ascertain available clinical instructor time for direct teaching activities. The relationship between the amount of clinical instructor time required and the competency level attained by students should be investigated. The relationship between the amount of responsibility that students are given for learning and the competency level attained by students should be investigated.

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APPENDICES

APPENDIX A

FORM A.1. Questionnaire I

COURSE ______________________________ UNIT NUMBER: ____________________

UNIT TITLE: ____

1. Identify the instructional strategies used for the above clinical experience unit.

FORM A.2. Questionnnaire II

Instructional Strategies / Teaching Activity	No. of Students	LECTURE	GROUP DISC.	IND. DISC.	READING LIST	CAI	VIDEOTAPE SIMULATION	AUDIO TAPE SIMULATION	COMPUTER SIMULATION	SIMULATED PROBLEM LEVEL 1	SIMULATED PROBLEM LEVEL 2	ACTUAL HOSP. EXPERIENCE	NON HOSPITAL EXPERIENCE	EXAMS	WRITTEN ASSIGNMENT	SELF PACED MODULE	ORAL PRESENTATION
		Time in Hours															

FORM A.3. Questionnaire III

COURSE ______________________________ UNIT NUMBER __________________

UNIT TITLE ____

1. Identify other instructional strategy mixes that you feel would be a suitable replacement for the instructional strategy mix currently used.

   A.

   B.

   C.

FORM A.4. Sample page of

Questionnaire IV*

I. INTERVIEWING AND COUNSELING UNIT
NUTRITION 4231 WINTER

INSTRUCTIONAL STRATEGY MIXES	LEVEL OF COMPETENCE				
(Circle your answer)	1	2	3	4	5

D_{11} Reading Assignment
Lecture/Group discussion
Video tape simulation
Group Critique
Self-evaluation - written

(Circle your answer)	1	2	3	4	5

D_{12} Reading Assignment
Group discussion
Video tape simulation
Individual critique
Self-evaluation - written

(Circle your answer)	1	2	3	4	5

D_{13} Reading assignment
Group discussion
Video tape simulation
Individual critique
Actual experience
Self-evaluation - written

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*The instructional strategy mixes for each clinical experience unit were presented on separate pages of Questionnaire IV.

APPENDIX B

APPENDIX B

A HEURISTIC PROCEDURE FOR MAXIMIZING COMPETENCY CONTRIBUTION OF UNITS IN RELATION TO AVAILABLE CLINICAL INSTRUCTOR TIME

Step 1

Select the instructional strategy mix with the highest competency contribution rating for each clinical experience unit. If two or more instructional strategy mixes for a clinical experience unit are tied for the highest rating, select the strategy mix with the lowest demand on clinical instructor time.

Example: Experience unit D_{13}

Experience unit D_{43}

Step 2

Add the competency contribution ratings (Table 9, p. 72) for the instructor strategy mixes selected in Step 1.

Example: $D_{13} = 5$

$D_{43} = 4$

$5 + 4 = 9$

Step 3

Using elemental time tables (Table 9) add the clinical instructor time required for the desired class size for the instructional strategy mixes selected in Step 1.

Example: Class size = 20 students

$D_{13} = 64.5$ $D_{43} = 59$

$64.5 + 59 = 123.5$

Step 4

Deduct the sum obtained for Step 3 from available clinical instructor time. If the difference is a positive value, the optimal solution is feasible. If the difference is a negative value, the optimal solution is not feasible and substitutions must be determined to minimize reduction of competency contribution with available instructor time.

Go to Step 5.

Example: 120 hours time available or .5 clinical instructor

$120 - 123.5 = -3.5$

Step 5

Set up optimal solution:

Example: $Z = \Sigma b_j x_j$ $\quad j = 1$ to n

$9 = 5D_{13} + 4D_{43}$

(SET UP TABLE FOR STEPS 6, 7, and 8).

TABLE	STEP 6	STEP 7	STEP 8
	$D_{12} - D_{13} = 3 - 5 = -2$	$40 - 64.5 = -24.5$	12.25
	$D_{41} - D_{43} = 4 - 4 = 0$	$82 - 59 = 23$	

Step 6

Deduct the competency contribution rating of the optimal instructional strategy mix in the solution from the competency rating of each of the alternative instructional strategy mixes for the clinical experience unit. (If the difference is ≥ 1, the optimal solution has an error).

Step 7

Deduct the clinical instructor time required for each optimal instructional strategy mix in the solution from the clinical instructor time required for each alternative instructional strategy mix for the clinical experience unit. (Positive values add to demand on clinical instructor time. Therefore, if all values are positive, a solution will be infeasible and additional mixes requiring less clinical instructor time are needed.)

Step 8

Divide the negative clinical instructor time obtained in Step 7 by the competency contribution rating obtained for the same pair of instructional strategy mixes in Step 6.

Step 9

Identify the instructional strategy mix that has the highest quotient obtained for Step 8.

Example: 12.25 or D_{12}

Step 10

Bring the instructional strategy mix identified in Step 9 into solution. Remove from the optimal solution the instructional strategy mix corresponding to the clinical experience unit of the instructional strategy mix going into solution.

Example: $Z = D_{12} + D_{43}$

D_{12} replaces D_{13}

Step 11

Add the competency contribution rating obtained in Step 6 for the instructional strategy mix placed in the solution in Step 10 to the competency contribution rating obtained in Step 2.

Example: 9 + (-2) = 7

Step 12

Add the clinical instructor time for the instructional strategy mix obtained in Step 7 to the clinical instructor time obtained in Step 3.

Example: 123.5 + (-24.5) = 99

Step 13

Deduct clinical instructor time obtained from Step 12 or 15 from available clinical instructor time. If the difference is a negative value, repeat Steps 6 through 13. If the difference is a positive value, the solution maximizes the competency contribution for available clinical instructor time.

Example: 120 - 99 = 21

Steps 14 through 16 are a check of the solution obtained in Step 13.

Step 14

Deduct the competency contribution rating of the instructional strategy mix in the solution for a given clinical experience unit from the competency rating of each of the other instructional strategy mixes available for the clinical unit. If a negative number is obtained, the solution cannot be improved because competency contribution will be reduced. If a positive value is obtained, then complete Steps 15 and 16 for each value.

Step 15

Deduct the clinical instructor time required for the instructional strategy mix in the solution from the clinical instructor time required for each of the alternative instructional strategy mixes that gave a positive competency rating in Step 14. If there are one or more negative values, bring the new instructional strategy mix with the highest value into the solution and remove its corresponding instructional strategy mix. Return to Step 13. If all values are positive go to Step 16.

Step 16

Deduct the value obtained in Step 15 from the value obtained in Step 13. If the difference is negative, the instructional strategy mix not in the solution cannot replace its corresponding strategy mix already in the solution. If the value is positive, the strategy mix not in solution could come into the solution replacing its corresponding strategy mix. If more than one strategy mix can come into the solution bring the mix with the highest competency value in first, the next highest second, and so on until time available in Step 13 is depleted but not exceeded. If the strategy mixes are tied for competency value, bring the mix into the solution that gives the highest value for Step 16, the next highest value second and so on until time available in Step 13 is depleted but not exceeded.

APPENDIX C

TABLE C-1. Matrix of Instructional Strategies for Basic Nutrition Clinical Experience Units.

INSTRUCTIONAL STRATEGIES / CLINICAL EXPERIENCE UNITS	CODE*	LECTURE	GROUP DISC.	IND. DISC.	READING LIST	CAI	VIDEOTAPE SIMULATION	AUDIO TAPE SIMULATION	COMPUTER SIMULATION	SIMULATED PROBLEM LEVEL 1	SIMULATED PROBLEM LEVEL 2	ACTUAL HOSP. EXPERIENCE	NON HOSPITAL EXPERIENCE	EXAMS	WRITTEN ASSIGNMENT	SELF PACED MODULE	ORAL PRESENTATION
Interviewing	N_{11}	X	X		X		X										
	N_{12}	X	X	X	X		X	X									
Medical Records	N_{21}	X	X	X											X		
	N_{22}	X	X							X					X		
	N_{23}		X		X					X							
	N_{24}	X	X		X					X					X	X	
	N_{25}	X	X		X					X					X	X	
Vitamins and Minerals	N_{31}	X	X		X								X		X		
	N_{32}	X			X								X		X		
	N_{33}	X			X								X		X		
	N_{34}		X		X								X		X		
	N_{35}		X		X								X		X		
Maternal Nutrition	N_{41}	X	X		X								X		X		
	N_{42}		X		X								X		X		
Infant and Child Nut.	N_{51}	X			X								X		X		
	N_{52}	X	X		X								X		X		
Adolescent Nutrition	N_{61}	X			X								X		X		
	N_{62}	X	X		X								X		X		
Senescent Nutrition	N_{71}	X			X								X		X		
	N_{72}	X	X		X								X		X		
	N_{73}	X	X		X								X				
	N_{74}	X	X		X								X		X		
	N_{75}	X	X		X								X		X		
Patient Interviewing	N_{81}		X									X			X		
	N_{82}		X									X			X		
Case Study	N_{91}	X										X			X		
	N_{92}	X										X			X		X
	N_{93}	X	X									X			X		X

*Explanation of Code

N_{ij} = ith instructional strategy mix for jth clinical experience unit for basic nutrition (N)

TABLE C-2. Matrix of Instructional Strategies for Nutrition and Disease Clinical Experience Units.

INSTRUCTIONAL STRATEGIES / CLINICAL EXPERIENCE UNITS	CODE*	LECTURE	GROUP DISC.	IND. DISC.	READING LIST	CAI	VIDEOTAPE SIMULATION	AUDIO TAPE SIMULATION	COMPUTER SIMULATION	SIMULATED PROBLEM LEVEL 1	SIMULATED PROBLEM LEVEL 2	ACTUAL HOSP. EXPERIENCE	NON HOSPITAL EXPERIENCE	EXAMS	WRITTEN ASSIGNMENT	SELF PACED MODULE	ORAL PRESENTATION
Interviewing and	D_{11}	X	X		X		X								X		
Counseling	D_{12}		X	X	X		X								X		
	D_{13}		X	X	X		X					X			X		
Charting	D_{21}	X		X	X					X							
	D_{22}	X		X	X							X					
	D_{23}	X		X	X					X							
	D_{24}	X		X	X					X		X					
Exchange Systems	D_{31}	X	X	X	X	X					X			X	X		
	D_{32}	X		X	X						X			X	X		
	D_{33}	X	X	X	X							X		X			
	D_{34}	X	X	X	X	X					X						
	D_{35}	X		X	X						X			X			
Nutritional Assessment	D_{41}	X	X									X			X		
	D_{42}	X	X	X						X		X			X		
	D_{43}	X	X	X						X		X			X		
	D_{44}	X		X						X					X		
Nutritional Care Plans	D_{51}	X	X	X								X			X		
Case Study	D_{61}		X	X								X			X		X
	D_{62}		X									X			X		

*Explanation of Code

D_{ij}=ith instructional strategy mix for jth clinical experience unit for nutrition and disease (D).

TABLE C-3. Matrix of Instructional Strategies for Foods and the Consumer Experience Units.

INSTRUCTIONAL STRATEGIES / CLINICAL EXPERIENCE UNITS	CODE*	LECTURE	GROUP DISC.	IND. DISC.	READING LIST	CAI	VIDEOTAPE SIMULATION	AUDIO TAPE SIMULATION	COMPUTER SIMULATION	SIMULATED PROBLEM LEVEL 1	SIMULATED PBOBLEM LEVEL 2	ACTUAL HOSP. EXPERIENCE	NON HOSPITAL EXPERIENCE	EXAMS	WRITTEN ASSIGNMENT	SELF PACED MODULE	ORAL PRESENTATION
Comparative shopping	F_{11}	X	X	X	X								X		X		
	F_{12}		X		X								X		X		
Mass Media	F_{21}	X	X	X	X		X								X		
Information for Adults	F_{31}		X		X								X				X
	F_{32}		X		X								X				X
	F_{33}		X		X								X		X		X
Information for Children	F_{41}	X	X	X	X								X		X		X
Children	F_{42}	X	X	X	X								X		X		X
Food Advertising	F_{51}		X												X		
	F_{52}		X												X		
	F_{53}		X												X		
Food Stamps	F_{61}		X	X	X								X		X		X
	F_{62}		X	X	X								X		X		
	F_{63}	X			X								X		X		
	F_{64}			X	X								X				X
Menu Planning	F_{71}			X	X						X				X		
Counseling	F_{81}		X									X			X		

*Explanation of Code

F_{ij}=ith instruction strategy mix for jth clinical experience unit for foods and the consumer (F).

APPENDIX D

TABLE D.1. Base, Minimum, Maximum and CIDMO and HRSISM Solutions to Problems Maximizing Competency Contribution Rating for Three Junior Level Clinical Courses with Clinical Instructor (CI) Time the Limiting Resource.

Basic Nutrition Problems			Nutrition and Disease Problems											Foods and the Consumer Problems		
Base ISM	Min. ISM	Max. ISM	Base ISM	Min. ISM	Max. ISM	1	2a	2b	3a	3b	4a	4b	4c	Base ISM	Min. ISM	Max. ISM
N_{11}	*	N_{12}**	D_{11}	D_{12}	D_{13}	D_{13}	*	D_{13}	*	D_{13}	*	D_{13}	D_{13}	F_{11}	*	F_{12}**
N_{21}	N_{22}	N_{25}**	D_{21}	D_{22}	D_{24}	D_{24}	*	D_{24}	*	D_{24}	*	D_{24}	D_{24}	F_{21}	*	*
N_{31}	N_{33}	N_{34}**	D_{31}	D_{34}	D_{33}	D_{33}	D_{35}	D_{33}	D_{33}	D_{33}	D_{35}	D_{33}	D_{33}	F_{31}	F_{33}	F_{32}**
N_{41}	N_{42}	N_{42}**	D_{41}	D_{44}	D_{43}	D_{43}	D_{44}	D_{43}	D_{44}	D_{43}	D_{44}	D_{44}	D_{43}	F_{41}	*	*
N_{51}	*	N_{52}**	D_{51}	*	*	*	*	*	*	*	*	*	*	F_{51}	*	F_{53}**
N_{61}	*	N_{62}**	D_{61}	D_{62}	*	*	*	*	*	*	D_{62}	*	*	F_{61}	*	F_{64}**
N_{71}	N_{73}	N_{74}**												F_{71}	*	*
N_{81}	*	N_{82}**												F_{81}	*	*
N_{91}	N_{92}	N_{93}**														

Problem 1: Class of 10 students; 0.75 CI position
2a: Class of 15 students; 0.75 CI position
2b: Class of 15 students; 1.00 CI position
3a: Class of 20 students; 1.00 CI position
3b: Class of 20 students; 1.50 CI position
4a: Class of 25 students; 1.00 CI position
4b: Class of 25 students; 1.50 CI position
4c: Class of 25 students; 1.75 CI position

* Base instructional strategy mix is in the solution

** Solutions for Problems 1-4c same as maximum competency

VITA

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