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A STRUCTURAL MODEL OF TRAINING AND CONFIDENCE AS PREDICTORS OF TIME SPENT TEACHING NUTRITION BY ELEMENTARY SCHOOL TEACHERS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN EDUCATIONAL PSYCHOLOGY MAY 1996

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Many factors, including nutrition background, determine the amount of time elementary teachers devote to nutrition instruction. The purpose of this study was to test theoretical structural models for the relationships among time spent teaching nutrition and several aspects of the teacher’s nutrition background: nutrition knowledge, training, and beliefs. I proposed two theoretical structural models. In the primary model, I hypothesized that teachers with more nutrition training would feel more confident in their ability to teach nutrition, and *because of that increased confidence*, would teach more nutrition. In the alternative model, I hypothesized that both training and confidence would directly and independently influence the time spent teaching nutrition. In addition, both models assumed that (1) nutrition knowledge had a direct influence on teacher confidence for teaching nutrition, and (2) a belief that nutrition instruction was important had a direct influence on the time spent teaching nutrition. I tested the primary and alternative models using data from a 1990-92 Nutrition Education and Training Program needs assessment survey, which was collected from a stratified random sample of all Hawai‘i elementary teachers (N=324). The survey included questions that could be used as measures of all the constructs of interest. Analysis of the covariance structures was completed using the CALIS procedure of SAS. Based on Chi-square and other indices of model fit, the primary model fit the actual data more closely than did the alternative model. Of the constructs included in the models, confidence was the strongest predictor of the time spent teaching nutrition. However, in the primary model all of the constructs explained only 12% of the variance in the time spent teaching nutrition and in the alternative model only 10% of the variance. In both models, nutrition knowledge was a statistically significant (*p* < .05) predictor of confidence for teaching nutrition, but belief that nutrition instruction was important was not a statistically significant predictor of the
time spent teaching nutrition. These results suggest that in elementary teachers, confidence in their ability to teach nutrition mediates the relationship between in-service training, nutrition knowledge, and the time spent teaching nutrition.
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CHAPTER 1
INTRODUCTION AND REVIEW OF THE LITERATURE

Problem Statement

There is widespread agreement that nutrition education should be included in elementary education (Thomas, 1991; U.S. Department of Health and Human Services, 1991; Maretzki, 1979; Shannon, Mullis, Bernardo, Ervin & Poehler, 1992). National objectives for health promotion and disease prevention in the United States, Healthy People 2000, were developed by a consortium of over 300 groups nationwide, facilitated by the U.S. Public Health Service. One of these objectives is to “increase to at least 75 percent the proportion of the Nation’s schools that provide nutrition education from preschool through 12th grade, preferably as part of quality school health education.” (U.S. Department of Health and Human Services, 1991, p. 95)

In addition, recommendations of the Institute of Medicine Food and Nutrition Board for implementing the U.S. Dietary Guidelines included these statements about nutrition education and teacher preparation (Thomas, 1991):

“Incorporate principles, concepts, and skills training that support dietary recommendation into all levels of schooling—kindergarten through college” (Thomas, 1991, p. 194).

“...urge state boards of education to mandate the inclusion of at least one food skills, nutrition, and health course in the requirements for teacher preparation in each state” (Thomas, 1991, p. 196).

Approaches to teaching nutrition vary, and the potential impacts nutrition education may have on students’ diets and health status depend on the approach taken (Contento, Manning, & Shannon, 1992). For example, some nutrition education programs have focused on improving students’ overall nutrition knowledge, while others have targeted
specific diet and disease links and stressed behavioral changes to reduce the risk for these diseases (Kalina, Philipps, & Minns, 1989; Contento et al., 1992). Appropriate measures of program success differ for these two types of programs. However, an underlying and necessary element of any approach to educating students about nutrition is for teachers to 

*devote instructional time* to the subject. Time spent on nutrition instruction may or may not be effective in increasing nutrition knowledge or bringing about behavioral changes, but clearly, only if nutrition education occurs can it have an impact. Adequate instructional time devoted to nutrition is not a sufficient condition to bring about the desired impact, but it is a necessary condition. The amount of time now spent by most elementary teachers in Hawai‘i (Lai et al., 1994) does not appear sufficient to bring about the desired changes in knowledge or behavior (Connell, Turner, & Manson, 1985). I will discuss this premise in detail in a later section of this chapter.

Given that time must be spent on nutrition education in elementary grades to bring about an impact, the question arises: How can nutrition educators encourage elementary teachers to devote more instructional time to nutrition? Elementary teachers face numerous demands on the instructional time they have available with their classes (Joint Committee on National Health Education Standards, 1995; Kalina et al., 1989). Nutrition is but one of the many topic areas that school systems require or encourage teachers to include in their classroom curriculum, and lack of time is a commonly perceived barrier to implementing nutrition education (Weiss & Kien, 1987). Recognizing this, nutrition education materials for elementary schools have often been developed for integration into several other subject areas (Kalina et al., 1989; Lytle & Achterberg, 1995; Shannon, Bell, Marbach, O'Connell, Graves, & Nicely, 1981). Nutrition activities may be structured to fit into mathematics, social studies, reading, or writing curricula, as well as into health or science. Teachers who are aware of these curricular options and wish to include more nutrition content in their classes may integrate these activities into other subjects, thereby
increasing the total amount of time they devote to nutrition. In Hawai‘i and elsewhere, then, elementary teachers may have substantial discretion in the amount of class time devoted to the subject of nutrition, either as a topic in health, in other curricular areas, or by itself.

Elementary teachers choose to assign more or less time to nutrition instruction depending on many curricular, school, student, and personal factors. Previous researchers have investigated some of the relationships between environmental and personal variables and the teaching of nutrition (Cook, Eiler, & Kaminaka, 1977; Farthing, Graves, Turchi, & Smith, 1989; Olson, Frongillo, & Schardt, 1986; Soliah, Newell, Vaden, & Dayton, 1983). I will present findings from these studies in a following section. Teacher training in the area of nutrition has been consistently identified as one of the factors related to teaching of nutrition (Contento et al., 1995; Contento et al., 1992; Cook et al., 1977; Lytle & Achterberg, 1995; Olson et al., 1986; Weiss & Kien, 1987). Several surveys have found that elementary teachers who have attended nutrition in-service training sessions are more likely to teach nutrition or teach it more thoroughly. The teachers who attend the trainings, though, may be those who are already very interested and planning to teach more nutrition anyway. If training elementary teachers in nutrition increases the amount of nutrition they teach, why does it? The relationship has been investigated only as an association, or by using training as a predictor of teaching nutrition. There has been little to no effort made to identify a structural relationship for the mechanism by which training may increase nutrition teaching.

The purpose of the present study is to propose and test structural models examining the relationships among time spent teaching nutrition and several aspects of the teachers’ nutrition backgrounds. For this study, the nutrition backgrounds of teachers are viewed as a combination of their nutrition knowledge, nutrition training, and nutrition attitudes or beliefs. These constructs will form the exogenous variables for the model. Two possible
structures for the relationship among these exogenous variables and time spent teaching nutrition will be tested. An additional construct, confidence in one's ability to teach nutrition, will be included as an intervening variable in the models. Research in other content areas has suggested that a teacher's confidence is a mediating factor in determining if training or other background factors influence their teaching of relevant content (Borchers, Shroyer, & Enochs, 1992; Paulussen, Kok, & Schaalma, 1994; Sheldon & Halverson, 1981; Smylie, 1988). I will present findings from these studies in a following section.

The Nutrition Education and Training Program

Nutrition education in school settings across the nation was transformed and energized almost 20 years ago with the introduction of the federal Nutrition Education and Training (NET) Program. Congress initiated the NET Program in 1977 to encourage school-based nutrition education and the integration of the school meals program with classroom nutrition education (Maretzki, 1979). This program provides federal funds to support nutrition education in the schools as part of the United States Department of Agriculture’s Child Nutrition Programs—school lunch and related programs. At the federal level, the scope of NET-funded nutrition education programs is conceptually broad, including student instruction, curriculum development and dissemination, in-service teacher training, and food service staff training (Kalina et al., 1989). The NET Program is the most comprehensive effort to promote nutrition education in United States schools, to develop curricular materials, and to train school personnel in implementation of nutrition education. However, since 1982, federal NET funds have been very limited and many of the programs implemented at the state or local levels have therefore focused on specific projects rather than comprehensive programs (Kalina et al., 1989). Teacher training projects have continued to be funded by NET in many states (Shannon, Mullis,
Bernardo, Ervin, & Poehler, 1992). In spite of the limited federal funds available, the Hawai'i NET Program has continued to offer teacher training sessions since 1980 (Lai et al., 1994).

In order to receive NET funds, a state must conduct a needs assessment and develop a program plan to address those needs (Maretzki, 1979; Kalina et al., 1989). In Hawai'i, the Curriculum Research and Development Group (CRDG) at the University of Hawai'i conducted an initial needs assessment for nutrition education in 1979-80 (Lai & Shimabukuro, 1980). This needs assessment was designed to provide information to use in developing a nutrition education program for Hawai'i. Based in part on the findings of this needs assessment, a state plan for nutrition education was developed to guide the Hawai'i NET program. Included in this program were the development of a sequential, integrated nutrition education curriculum for preschool through grade 12 and in-service training sessions for teachers in the implementation of this curriculum (Lai et al., 1994).

In 1990, the State Department of Education contracted with the CRDG to conduct a follow-up needs assessment to identify changes since 1980 in nutrition knowledge, attitudes, and behaviors and to assess the ongoing needs for nutrition education and training in Hawai'i schools (Lai et al., 1994). The 1990-92 NET needs assessment included a survey of a stratified random sample of public school teachers in Hawai'i as well as surveys of students, parents, school food service managers, and school nurses. A wide range of information concerning nutrition training, knowledge, attitudes, and practices was collected from this sample of teachers (Lai et al., 1994).

Status of Elementary School Nutrition Instruction in Hawai'i

Nutrition is not required as a separate curricular component in most states. As of 1992, only nine states mandated nutrition as a curricular area; an additional 21 mentioned nutrition as a required topic in another mandated curricular area, usually health (Shannon
et al., 1992). In Hawai‘i, nutrition knowledge, attitudes, processes, and skills are integrated with other health topics as part of the *Essential Content*, which lists the “content considered essential for students to know and teachers to address” (Hawai‘i State Department of Education, 1992). Nutrition concepts are also identified in the student performance expectations for the Foundation Program Objectives (Hawai‘i State Department of Education, 1993) and in the Health Education Framework (Hawai‘i State Department of Education, 1995). However, none of these documents indicate any minimum amount of instructional time that must be spent on nutrition instruction. Therefore, although Hawai‘i elementary teachers are expected to address nutrition concepts, they have discretion in how much emphasis nutrition should have, and how much of their class time will be devoted to the topic.

The Hawai‘i Nutrition Education Instructional Guides, a set of curricular guides for preschool through grade 12 nutrition education, were developed in the 1980s through the NET program. The guides for elementary grades are interdisciplinary in nature and in their intended implementation (Hawai‘i State Department of Education, 1984). Teachers trained in or familiar with these curricular guides can integrate nutrition content into language arts, mathematics, science, and social studies as well as teach nutrition as part of health lessons. The Hawai‘i State Department of Education (1994) has since developed and distributed an additional nutrition education resource, *Learn from Lunch*. This resource includes brief activities that elementary teachers can use as pre-lunch or post-lunch activities, or as part of morning circle time, health lessons, or science lessons. Each lesson recommends additional activities that may tie the nutrition lesson to reading, social studies, mathematics, or music. The interdisciplinary curricular materials that have been developed in Hawai‘i expand the opportunities for elementary teachers in Hawai‘i to increase the time they spend on nutrition. Weiss and Kien (1987) recommended integrating nutrition instruction into other subjects, as these curricular guides do, as a way
to deal with the lack of time elementary teachers have reported as a barrier to nutrition education.

**Time Devoted to Nutrition Instruction and Necessary to Produce an Effect**

In the 1990-92 Hawai'i NET Needs Assessment (Lai et al., 1994), most elementary teachers reported teaching nutrition on either a “monthly” or “yearly” basis; 39% of the sampled teachers reported that they taught nutrition “yearly” and 37% “monthly.” Only 21% of the teachers reported teaching nutrition on a “weekly” basis, and one percent reported teaching it “daily.” Two percent of the sample reported that they never taught food and nutrition concepts. The results of this survey showed an increase over time in the number of elementary teachers who at least teach some nutrition. In 1979-80 the percentage of teachers who reported that they did not teach nutrition at all was 19% of the kindergarten to grade three teachers and 38% of the grades four through six teachers (Lai & Shimabukuro, 1980). The amount of time spent teaching nutrition was also assessed in the 1990-92 survey (Lai et al.). Almost one half of the elementary teachers reported spending one hour or less teaching food and nutrition concepts, *within the frequency of teaching nutrition that they had identified*. Twenty percent reported teaching for 2 to 3 hours, 13% for 4 to 5 hours, and 14% for more than 5 hours. Again, 2% reported that they never spend time teaching food and nutrition concepts. The approximate total amount of time per year that these teachers spent on nutrition instruction was estimated from the survey responses. About 29% of the teachers taught nutrition for less than 5 hours per year, about 37% taught from 5 to 10 hours per year, about 10% taught from 10 to 20 hours per year, about 21% taught from 30 to 40 hours per year, and only about 3% taught nutrition for more than 40 hours per year.

Researchers elsewhere have also investigated the amount of time elementary teachers spend teaching nutrition. Cook et al. (1977) reported that teachers in their sample spent
an average of 9.7 hours per year on foods and nutrition. Teachers in primary grades reported spending slightly more time on nutrition than those in grades four through six. The distribution of hours taught was highly skewed; about one-fourth of the teachers did not teach nutrition at all, and one-fifth of the teachers accounted for more than half of the total number of hours of nutrition taught. Olson, Frongillo, and Schardt (1986) reported similar results from their 1981 survey of a sample from the same population base. While the 68% percent of their sample that reported teaching nutrition was smaller than the 75% reported by Cook et al. (1977), they attributed the difference to a higher return rate on their survey. The average amount of time spent teaching nutrition in 1981 was 11.1 hours for the total sample, and excluding those respondents who never taught nutrition, the average was 16.3 hours. In a small survey in one rural New York State school district, 29% of the respondents reported teaching no nutrition at all, and the average amount of time spent on nutrition was reported as 1.7 weeks per year (Brown & Park, 1986).

Shannon, Bell, et al. (1981) reported on the time spent by elementary teachers implementing a new nutrition education curriculum for elementary students and student knowledge gain. The test of nutrition knowledge was based on the topics covered in the curriculum. The number of lessons taught were fewer than the number requested by researchers as part of the experimental design. Teachers reported using from 32 percent (fourth grade) to 73 percent (kindergarten) of the assigned lessons. The total average amount of time that teachers reported spending on the lessons ranged from 1.7 hours (kindergarten) to 8.4 hours (fifth grade). Students who had received instruction using the nutrition curriculum demonstrated gains in nutrition knowledge, compared to students in control (no instruction) groups. However, any relationship between the amount of classroom time spent teaching nutrition and knowledge gains was not reported. This research indicates that some program specific knowledge gains may occur with relatively small amounts of instruction.
In their review of effective strategies to improve children’s diets, Lytle and Achterberg (1995) identified six elements of effective eating behavior change programs. One of these elements was spending sufficient time on instruction or intervention. The authors concluded that in order to impact student eating behaviors, the present 10 to 15 hours per year of nutrition education is inadequate and that “more is better” (p. 253).

No national organization has made a recommendation concerning the minimum amount of time that should be devoted to nutrition education, but the Joint Committee on National Health Education Standards (1995) has recommended that 50 hours per year be spent on health education in U.S. schools. This recommendation was based on results of the School Health Education Evaluation (SHEE) (Connell et al., 1985), in which the amount of time spent on health education in order to produce an effect on program-specific knowledge, general knowledge, practices, and attitudes was studied. SHEE examined the impacts of four different health education curricula as implemented in elementary schools. The researchers found that at least 30 hours of classroom instruction time was necessary to produce a “medium” size effect on general health practices, while approximately 20 hours could produce a similarly-sized increase in general knowledge. The definition of a “medium” size effect was an increase from pretest to posttest in the mean score of 50% to 80% of the overall standard deviation. Program-specific knowledge gains of similar size were obtained within 10 to 15 hours of instruction. The effects obtained in knowledge, practices, and attitudes reached stable levels with about 50 hours of classroom instruction. In the area of nutrition, it would appear that from 30 to 50 hours of instruction could be necessary to produce behavioral or attitude changes; this amount of time could also be expected to produce “large” (≥ 80% of the overall standard deviation) changes in general nutrition knowledge. Teachers who spend less than 10 to 15 hours on nutrition instruction, as do about two-thirds of Hawai‘i’s elementary teachers, should expect to have an impact on program-specific knowledge alone.
In health education, as in nutrition education, there is concern that not enough time is being devoted to instruction to be effective in changing behavior. An average of 13.8 hours per year are reportedly spent on health education in U.S. schools compared to the 50-hours recommendation (Joint Committee on National Health Education Standards, 1995). Suggestions have been proposed for integration of health curriculum into other subject areas, in order to make connections across subjects and to save instructional time (Joint Committee on National Health Education Standards). These suggestions are very similar in focus and rationale to the recommendations to integrate nutrition into other content areas, as exemplified by the Hawai'i nutrition education guides (Hawai‘i State Department of Education, 1984).

**Elementary Teachers’ Backgrounds in Nutrition**

Nutrition course requirements for teacher certification in 44 states were compiled by Shannon, Mullis, Bernardo, Ervin and Pohler (1992). Six states required nutrition course work for certification as an elementary teacher, and one state required nutrition “competency” for certification as an elementary teacher. Two other states noted that nutrition was “expected but not required” or was “considered a part of health education” (p. 91). Still, the majority of states do not require any specific background in nutrition for individuals to be certified as elementary teachers.

Traditionally in the United States, few elementary teachers have had formal training in nutrition beyond what may be covered in a college biology or health class. Petersen and Kies (1972) reported that in a 1970 survey of a random sample of Nebraska primary teachers, only 9% had taken a separate nutrition course in college, while 59% had nutrition included in a health, biology, or other course, and 33% had had no nutrition at the college level. In addition, 83% reported that they had had no training in nutrition education methods. In a 1975 survey in New York State and New Jersey, Cook et al.
(1977) also found low levels of nutrition preparation among elementary teachers. While 22% of the sampled teachers reported having taken a formal college level foods or nutrition course, only 3% had attended an in-service workshop on nutrition or foods.

The situation changed somewhat with the development of teacher-training workshops funded by the NET Program, starting in about 1979. In 1981, Olson et al. (1986) surveyed the same population of teachers that had been surveyed by Cook et al. (1977) and found that the percentage who reported having attended in-service trainings had risen dramatically—from 3% to 23%. Similarly, about 20% of the elementary teachers in a 1979-80 Kansas survey reported having attended a nutrition workshop (Soliah et al., 1983). Among self-selected groups of teachers who have enrolled in nutrition workshops, the percentage who have had prior training in nutrition may be higher. Neafsey, Jensen, and Burkland (1985) reported that in 1980 to 1982, 41% of the elementary teachers signing up for an in-service nutrition course had had prior nutrition training.

In North Carolina, Farthing, Graves, Turchi, and Smith (1989) compared the nutrition background and training of teachers in schools that were active in the NET Program with teachers in matched schools that were not active in NET. In non-NET schools, 20% of the teachers had taken part in in-service nutrition workshops, similar to the percentages reported by Soliah et al. (1983) and Olson et al. (1986). In contrast, 88% of the teachers in NET schools had attended a nutrition workshop. There were no statistically significant differences between the two groups of teachers in the percentage who had college courses in nutrition (5% overall) or who had taken a college course which included a nutrition unit (25% overall).

Hawai‘i elementary teachers reported having received varying amounts of nutrition training. In 1991, 32% reported that their degree programs included courses in food and nutritional science, nutrition education methods, or both. Only 28% had attended in-service training sessions in food and nutrition science, nutrition education methods, or
both during the past five years. Fewer than 10% reported having attended a NET-sponsored training session (Lai et al., 1994). The amount of training Hawai’i elementary teachers have received appears to be fairly stable over time. In 1980, 28% of the surveyed kindergarten to third grade teachers and 23% of the surveyed fourth to sixth grade teachers reported that their college degree programs included courses in food science, nutritional science, or methods in food and nutrition education (Lai & Shimabukuro, 1980). Similarly, 30% of the surveyed kindergarten to third grade teachers and 34% of the surveyed fourth to sixth grade teachers reported having attended in-service training in these areas. In addition, only 17% of the elementary teachers in the 1990-92 Hawai’i NET study reported that their usual source of nutrition information was from “classes, lectures, workshops, or demonstrations,” while almost two-thirds reported their usual source as “newspapers, magazines, books, television, or radio” (Lai et al., 1994).

Nutrition knowledge is an additional aspect of elementary teachers’ nutrition background that is relevant to the current study. The nutrition knowledge of Hawai’i elementary teachers was also assessed in the 1990-92 Hawai’i NET study (Lai et al., 1994) using 24 questions related to the Dietary Guidelines for Americans (U.S. Departments of Agriculture and Health and Human Services, 1990). The mean knowledge score for the elementary teacher sample was 20.4 out of 24. This score suggests that Hawai’i elementary teachers have a fair to good knowledge of nutrition, at least in comparison to a sample of the parents of fifth grade students who had an average score of 15.8 on the same questions.

**Relationship of Teacher Training to Nutrition Instruction**

Nutrition training presumably enhances nutrition knowledge among participants; in several studies that measured this variable, teachers have shown statistically significant gains in nutrition knowledge after nutrition training (Contento et al., 1995; Neafsey et al.,
1985; Stark & Johnson, 1981). The relationship between teacher training and its impact on the nutrition education the teachers later provided to students has not been widely studied, but reviewers have concluded that there is a positive relationship based on the research available (Weiss & Kien, 1987; Contento et al., 1992). Contento et al. (1992) reviewed the few studies examining the relationship of teacher training to nutrition instruction and reported that these studies have had conflicting findings. The authors concluded that it is likely teacher training has a positive impact on teacher attitude and amount of time devoted to nutrition instruction but acknowledged that this impact may be a result of the self-selection of more interested teachers attending training sessions. In 1995, Contento et al. suggested that the failure in some studies to find a relationship between teacher training and the quantity of nutrition instruction provided may be due to the limited time available for nutrition instruction in the school curriculum.

Two experimental studies have examined the relationship of teacher training in nutrition to nutrition instruction in elementary grades (Shannon, Bell, et al., 1981; Tinsley, Houtkooper, Engle, & Gibbs, 1985). Both of these studies assessed the effect of various levels of teacher training on student knowledge gain after implementing a new nutrition education curriculum.

Shannon, Bell, et al. (1981) assessed the effect on student outcomes of three levels of teacher preparation. They found that nutrition knowledge gains were consistently greater among the elementary students who had received nutrition instruction than for students in control (no instruction) groups. However, the effect of teacher training on student outcomes was inconsistent. For some grades, student knowledge gains were greater for those students whose teachers had received additional training, but for other grade levels this relationship did not hold true. The authors concluded that since knowledge gains were greater in all instructed groups than in controls, teacher training appeared to be unnecessary for successful implementation of this nutrition curriculum.
Tinsley et al. (1985) also assessed the effect on student outcomes of three levels of teacher preparation. They found positive knowledge and attitude changes only in students of teachers who had received the most intensive training, and this was true only for one of the two grade levels assessed. The intensive training in this study consisted of a workshop and 12 hours of ongoing consultation throughout their implementation of the curriculum. The authors suggested that in the case of this curriculum, the ongoing consultation may have motivated teachers to implement the entire curriculum rather than focusing only on parts of it. In this case, teaching the entire curriculum may have been necessary in order to document improvements in student knowledge and attitudes.

Neither study compared the level of teacher training to the amount of time spent teaching nor to the fidelity of curriculum implementation. In addition, both studies relied, at least to some extent, on teachers volunteering for the nutrition training. They leave unanswered the question of whether teacher training directly influences the amount of time spent teaching nutrition.

It appears that teachers who voluntarily choose to attend a training program in nutrition may be more likely to teach nutrition, or to teach it more, than they did before receiving the training. For example, Neafsey et al. (1985) conducted a nutrition education course for 140 self-selected elementary teachers. Of the 66% of these teachers who returned a survey form \( n = 91 \), 87% reported teaching nutrition after the training, compared to 57% who reported teaching nutrition before taking the training. However, they reported that this difference was not statistically significant (probability level not reported). Brown and Park (1986) also reported an increase in the extent of teaching nutrition among a self-selected group of elementary teachers who had received in-service training. The elementary teachers who participated in their training doubled the “average amount of instructional hours devoted to nutrition education.” (No statistical information
was provided.) The question of whether or not the changes seen in these self-selected teacher samples are relevant to other elementary teachers remains to be answered.

In several surveys of random samples of teachers, researchers have investigated the relationship between teaching nutrition and possible predictor variables, including training in nutrition. Cook et al. (1977) found a positive relationship between in-service nutrition training and teaching of nutrition but cautioned that the relationship was only associative. They noted, “It should be recognized that other variables, such as teacher interest, basic teacher attitudes, etc., may be the causal factors for both the teacher’s nutrition training and subsequent classroom actions” (p. 133). In a 1981 survey (Olson et al., 1986), the percent of elementary teachers who reported that they had attended in-service trainings had increased substantially in comparison to the Cook et al. survey. However, the percentage who reported teaching nutrition had not changed. Olson et al. concluded that participation in in-service training is only “weakly related” to the amount of time spent on nutrition education, but that training is more strongly related to whether or not nutrition is taught.

**Relationship of Teacher Training to Health Instruction**

The teaching of nutrition in elementary schools is closely associated with health instruction. Nutrition as a subject area is often considered a sub-component of health; both are concerned with changing student behaviors as well as increasing knowledge, and in both subject areas the same concern of inadequate instructional time exists. Studies in the field of health education that have attempted to assess the impact of elementary teacher training on curricular implementation, then, are relevant to this research.

A number of health education researchers have examined the implementation of new health education curricula in elementary schools. The focus of most of these studies has been on student outcomes, and teacher training has usually been viewed as a necessary
step to ensure implementation of the new curriculum. I will review the findings, conclusions, or implications from these studies that are relevant to the present study in this section.

Teacher implementation of a new health curriculum is clearly not automatic nor is it consistent. Basch, Sliepcevich, Gold, Duncan, & Kolbe (1985) conducted a case study of five elementary teachers to determine the extent to which these teachers had implemented the School Health Curriculum Project. The researchers found that implementation varied widely, with only 34% of the activities implemented as planned or modified by all five teachers, and 24% of the activities omitted by at least one of the teachers. The researchers cautioned that programs implemented by teachers “are likely to be very different from what was intended or assumed” (p. 327).

The School Health Education Evaluation (SHEE) assessed the impact of four different health education curricula in different schools (Owen et al., 1985). Connell, et al. (1985), reporting on SHEE, noted that teachers who had received training implemented programs more completely than those who had not attended the training. Although it was not explicitly stated, it appears that all of the teachers who received training were volunteers (Owen et al., 1985). The amount of teacher training varied with the curriculum, from none to 40 to 50 hours (Owen et al.). Since the amount of training varied so widely among the studied curricula, it is possible that the effects reported for training could actually be attributable to other aspects of a specific curriculum.

Smith, McCormick, Steckler, and McLeRoy (1993) also assessed the extent of implementation for several health education curricula. Their research design included randomization of school districts into experimental and control groups. Districts in the experimental group were offered teacher training in the use of the curriculum that the district had selected, and 67% of the eligible teachers participated in the training sessions. Training lasted either two or four days, based on the curriculum chosen. Teachers in
control group districts were not offered these training sessions but were provided with the curricular materials. Teachers who received training were more likely to implement a curriculum and were more likely to continue teaching it. However, training was not found to be related to completeness of implementation. Teachers who had received training did not spend more time teaching the curriculum than those who had not.

Separate evaluations of the effectiveness of the “Know Your Body” elementary health education program were conducted by Bush et al. (1989) and by Resnicow et al. (1992). All teachers participating in either of these projects were trained in use of the curriculum, but implementation was reported to be low and uneven. Researchers reported that “in no classroom did the teacher teach the curriculum as it was intended, in terms of either quality or quantity” (Bush et al., p. 224) and that “program effects were significantly related to the degree of teacher implementation” (Resnicow et al., p. 478). Both groups of researchers concluded that assessing and improving the implementation of this curriculum were essential if it were to have a positive impact on student health behaviors. Bush et al. noted that teachers had trouble finding time to teach this new curriculum and that they were not held accountable by school administrators for teaching it. Resnicow et al. suggested that the barriers to implementation may be too great for a generalist classroom teacher, and that specialists may be needed to teach such programs effectively.

Parcel, Simons-Morton, O’Hara, Baranowski, and Wilson (1989) reported similar findings in a study of the impact of the “Go For Health” program. Teachers received formal in-service training on the curriculum and technical support from a specialist. The researchers found that implementation of the curriculum was uneven, and the most frequent reason given by teachers for this was lack of time. The authors suggested that the in-service training provided was insufficient and noted that “staff training is critical for influencing the interest and motivation of teachers” (p. 197). They further suggested that “while administrative support and staff training are essential in program implementation,
the commitment of teachers and staff...is also important“ (p. 198). From their experience with the project, they recommended the identification and use of teacher incentives to encourage program implementation.

Maximizing the Potential Impact of Teacher Training

The mixed results from studies of teacher training and subsequent curriculum implementation in both nutrition education and health education are probably the result of several factors. First, the extent to which teachers attended training sessions on a voluntary basis, or were pressured to attend, is not clear. Second, the types of training teachers received appear to have greatly differed, at least in length. Third, other factors outside of the teachers’ or researchers’ control may have large influences on the implementation of new curricula in any subject. These factors may include support from school and district administrators, facility limitations, the educational needs of students, and the perceived lack of time to implement a new curriculum.

The extent to which an elementary teacher teaches nutrition is most probably determined by a combination of many curricular, school, student, and personal factors, including the teacher’s background and training in nutrition. Many of these factors, such as grade level taught, administrative support for nutrition education, and other curricular demands, are not under the control of nutrition educators attempting to increase the time spent teaching nutrition. However, providing nutrition training is possible, and therefore continues to be the focus of many attempts to improve elementary nutrition education. In Contento et al.’s (1992) review of school-based nutrition education, the authors concluded, “Teacher training is likely to result in increased time spent on teaching nutrition in the classroom and, consequently, in [its] improved effectiveness” (p. 257), even though they earlier noted, “...whether teacher preparation actually makes a
difference in nutrition education of children was examined in only a few studies, and the results were conflicting” (p. 252).

Since training is a modifiable factor related to nutrition teaching, it may be important to maximize the potential impact of training by better understanding its relationship with nutrition teaching. Several models have been proposed that relate teacher training and other factors to nutrition instruction. I will review these models in the following section.

Models for Teaching Nutrition in Elementary Schools

Cook, Eiler, and Kaminaka (1977) proposed two statistical models (Table 1) to explain the amount of nutrition being taught in elementary schools, one for teaching or not teaching nutrition (a probit model), and one for amount of time spent on nutrition (a regression model). These models were based on relationships identified from their survey of a random sample of 2,160 elementary teachers in New York and New Jersey.

Both the likelihood that a teacher taught nutrition and the amount of time spent teaching nutrition were associated with having had prior nutrition training, either in high school, college, or workshops; with the perception that nutrition was important; and with the perception that nutrition is most effectively taught at the grade level they teach. In addition, the likelihood that a teacher taught nutrition was also associated with the grade level taught (Grades K-3 teachers were more likely to teach nutrition than grades 4–6 teachers); and with geographic region (New Jersey teachers were less likely than New York teachers to teach nutrition). The researchers noted that although training in nutrition appeared to increase the likelihood of teaching nutrition and the amount taught, this relationship was only associative. They suggested that other variables such as interest and attitudes could have a causal relationship with both nutrition training and teaching.
<table>
<thead>
<tr>
<th>Authors and Type of statistical model</th>
<th>Cook et al. (1977)</th>
<th>Olson et al. (1986)</th>
<th>Cook et al. (1977)</th>
<th>Olson et al. (1986)</th>
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<td>Probit</td>
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<td>Regression</td>
<td>Linear</td>
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**Dependent variable:**  
- Likelihood of teaching nutrition
- Likelihood of teaching nutrition
- Time spent teaching nutrition
- Extent of teaching nutrition
- Nutrition education practices

**Independent variables in model:**  
✓ = variable a statistically significant predictor ($p < .05$)  
$ns$ = variable not a statistically significant predictor  
blank = variable not mentioned in model

**Training:**  
- Attended in-service training ✓ ✓ ✓ ✓ ✓  
- High school course ✓ ✓ ✓ ✓ ✓  
- College or continuing ed. course ✓ ✓ ✓ ✓ ✓  

**Personal attitudes/beliefs:**  
- Perceive nutrition is important ✓ ✓ ✓ ✓ ✓  
- Perceive nutrition most effective ✓ ✓ ✓ ✓ ✓  
- at their grade level ✓ ✓ ✓ ✓ ✓  
- Thought teaching had effect on students ✓ ✓ ✓ ✓ ✓  
- Extremely interested in subject ✓ ✓ ✓ ✓ ✓  
- “Nutrition-related attitudes” ✓ ✓ ✓ ✓ ✓  

**Personal attributes:**  
- Nutrition knowledge ✓ ✓ ✓ ✓ ✓  
- Self influential in decision to teach ✓ ✓ ✓ ✓ ✓  
- “Nutrition-related practices” ✓ ✓ ✓ ✓ ✓  
- Years of experience $ns$ $ns$ $ns$ $ns$ $ns$  

**Student attributes:**  
- Students influential in decision to teach ✓ ✓ ✓ ✓ ✓  
- Interest of students ✓ ✓ ✓ ✓ ✓  
- Students have nutrition problems ✓ ✓ ✓ ✓ ✓  
- Grade level ✓ ✓ $ns$ $ns$ $ns$  
- Classroom or specialty teacher ✓ ✓ ✓ ✓ ✓  

**Nutrition Education Practices:**  
- Teach integrated as well as separately ✓ ✓ ✓ ✓ ✓  
- Taught it before ✓ ✓ ✓ ✓ ✓  

**School context:**  
- School administrators interested ✓ ✓ ✓ ✓ ✓  
- Principal influential in decision to teach (negative effect) ✓ ✓ ✓ ✓ ✓  
- Number of teaching plans ✓ ✓ ✓ ✓ ✓  
- Geographic region $ns$ $ns$ $ns$ $ns$ $ns$  

Table 1.  
*Models Developed to Explain Variance in the Teaching of Nutrition in Elementary Schools*
Olson, Frongillo, and Schardt (1986) also attempted to explain the amount of nutrition being taught in elementary schools. They proposed two statistical models (Table 1) based on their survey of a random sample of 1331 elementary teachers in New York and New Jersey. The researchers developed a logistic regression model to explain whether or not teachers taught foods and nutrition, and a linear regression model to explain the variance in the extent of teaching foods and nutrition. The dependent variable “extent of teaching” was defined as a sum of the following variables: the number of hours food and nutrition was taught, the number of months it was taught, the number of topics covered, and the number of materials used. Six predictors were found to explain 26% of the variance in extent of teaching. Teachers who reported that they were extremely interested in the subject spent 60% more time teaching nutrition; those who thought their teaching had an effect on students spent 35% more time; those who taught nutrition integrated with other subjects as well as separately spent 23% more time; and those who had participated in an in-service training workshop spent 10% more time. Teachers who had noticed nutrition problems among their students and those with more nutrition teaching plans available also spent more time on the subject than other teachers.

Another statistical model, based on a survey of a representative sample of Kansas elementary teachers, identified relationships between teacher background and undefined “nutrition education practices,” as shown in Table 1 (Soliah et al., 1983). Teachers who had reported taking college or continuing education courses in nutrition rated higher on the “nutrition education practices” scale. These “nutrition education practices” were also found to be correlated with teachers’ nutrition-related attitudes and practices and with their nutrition knowledge.

Farthing et al. (1989) posited a conceptual model, which also differed from the models described above, by positioning training as an endogenous variable (Figure 1). Variables that may explain why teachers choose to attend training sessions were included
in the model. These variables were the provision of continuing education credit and free materials. In this model, training is seen as leading directly to "more support for nutrition education."

![Diagram of support for nutrition education through training]

**Figure 1.** Farthing et al.'s (1989) model of support for nutrition education through support for training.

As early as 1981 (Shannon, Marbach, Graves, & Sims) nutrition education researchers were recommending that in future studies of teacher training for nutrition education, attention needed to be given to developing a positive attitude in teachers about including nutrition in their curricula. The models suggested above included measures of certain nutrition-related attitudes. The Olson et al. (1986) model also included a variable "thought their teaching had an effect on students." However, none of these researchers attempted to identify a structural relationship that included possible reasons why teacher training might result in the teachers implementing more nutrition education. In this study, I examine the structural relationships among teacher training, the amount of time spent teaching nutrition, and the possible intervening variable of teacher confidence for teaching nutrition. I will describe the rationale for including teacher confidence as an intervening variable in the next section.
Teacher Confidence (Self-efficacy) and Relationship to Teaching Practices

"Given appropriate skills and adequate incentives...efficacy expectations are a major determinant of people's choice of activities..." Bandura, 1977 (p. 194)

Teacher confidence (self-efficacy)

Bandura's social learning theory, including the concept of self-efficacy, has been widely used as a theoretical model to direct nutrition education research and to provide a framework for efforts to effect behavioral changes in nutrition-related areas. (Achterberg & Clark, 1992; Glanz & Eriksen, 1993; Glanz, Lewis, & Rimer, 1990; Glanz & Rudd, 1993; Parcel et al., 1987; Perry, Baranowski, & Parcel, 1990; Thomas, 1991). In some content areas, the concept of self-efficacy has also played a central role in research attempting to influence teachers' instructional practices or student outcomes (Borchers et al., 1992; Gibson & Dembo, 1984; Midgley, Feldlaufer, & Eccles, 1989; Sheldon & Halverson, 1981; Smylie, 1988). Training in the subject, knowledge of subject matter, and knowledge of curricula are undoubtedly associated with the time teachers spend teaching a subject. However, as Bandura (1977) noted, these relationships between teacher background factors and their teaching practices may be mediated by the teacher's confidence, or self-efficacy.

In 1979, Maretzki stated that, in her experience, "Teachers often lack self-confidence about and enthusiasm for nutrition education because they view nutrition as a college-level subject dealing with concepts which they themselves do not fully grasp" (p.178). However, while self-efficacy has been acknowledged as an important concept related to dietary change, teacher confidence or self-efficacy to teach nutrition has seldom been mentioned in nutrition education studies.\footnote{The exception is a 1983 study of the nutrition-related characteristics of high school teachers and dietary change in their students, which included a measure of teacher confidence and found it to be a statistically significant ($p < .05$) predictor of change (Skinner & Woodburn).} Only recently has the potential importance of
teacher confidence as a mediating factor between teachers’ backgrounds and their
teaching practices been mentioned in the nutrition education literature. Based on their
review of research in nutrition education, Contento et al. (1995) drew the following
implication for teacher preparation in this area: “Targeting the needs of teachers is
important. In the case of nutrition education, this means directing inservice at increasing
teachers’ knowledge of nutrition and confidence as nutrition educators” (p. 349, italics
added).

Confidence and teaching practice in health education

Similarly, in the health education literature teacher confidence or self-efficacy has not
often been identified among the desired outcomes of teacher training or included in
studies of health curricula implementation. The National Action Plan for Comprehensive
School Health Education (1993) included professional preparation and practice as a
critical issue but did not identify teacher confidence in ability to teach health as a concept
in either its pre-service or in-service training recommendations. Lavin (1993) also
identified the lack of adequate teacher training as a major obstacle to the implementation
of health education, noting that “many teachers feel uncomfortable with certain areas of
the health curriculum” (p. 26). However, Lavin did not address the issue of how to
enhance teacher confidence or what type of training may be most effective in influencing
teacher confidence. In outlining a model for staff development in health education
Gingiss (1992) noted that, “even among enthusiastic trainees, successful implementation
and maintenance do not automatically follow successful initial training.” Her model did
include a mention of “increasing self-efficacy” as a task during one phase of staff
development, but focused more on other aspects of the training and follow-up.

In one of the few health education studies to measure a construct similar to teacher
confidence, Ross, Luepker, Nelson, Saavedra, and Hubbard (1991) assessed the impact of
in-service training on teachers’ “self-reported preparedness” and on implementation of the *Teenage Health Teaching Modules*, a secondary school health curriculum. Teachers were assigned randomly to a training or a no-training group, but the design accommodated the expectation that a certain number of the teachers assigned to the training group would be “no shows.” These teachers were added to the no-training group. After using the new curriculum for a semester, the researchers assessed the teachers’ “self-reported preparedness” by asking them to look back and rate how prepared they felt at the beginning of the semester to use the curriculum. Using multiple regression analysis, they found that 31% of the variance in “self-reported preparedness” could be explained by attending the in-service training ($\beta = .55; p < .0001$) and by being an uncertified health teacher ($\beta = -.18; p < .05$). The researchers also assessed the degree of implementation of the curriculum; they found significant differences between trained and untrained teachers in the percentage of required activities taught ($p < .005$) and in the degree of fidelity to the curriculum ($p < .01$). No statistically significant difference was found, however, in the number of minutes spent on required modules. In addition, no significant differences were found between the no-training and the no-show group for any of the implementation measures. This study provided evidence in the area of health education that training can have an impact on teachers’ perceptions of their preparedness to teach a given curriculum and on some implementation measures. However, the researchers did not examine any possible relationship between the teachers’ perceptions of their preparedness and their implementation of the curriculum.

In a Dutch study of the determinants of adopting AIDS education in the classroom, self-efficacy was identified as an important antecedent to change (Paulussen, Kok, & Schaalma, 1994). Their theoretical structural model explaining a teacher’s decision to implement AIDS education did not include teacher training but did include self-efficacy, outcome beliefs, and subjective norms as factors that would mediate the influence of the
teacher's general disposition (student-centeredness, responsibility, stability, controllability, and sexual morality) and the interactive context (school policy, collegial interaction, perceived consensus, and descriptive norms) on adoption of AIDS education. Using multiple regression analysis, the researchers found that 35% of the variance in teachers’ intention to implement AIDS education could be explained by the three mediating factors (subjective social norms, self-efficacy, and outcome beliefs).

Teacher self-efficacy was also included in the design of a process evaluation of the Child and Adolescent Trial for Cardiovascular Health (CATCH), an elementary school-based study designed to decrease cardiovascular risk factors (Stone, 1994; McGraw et al., 1994; Edmundson et al., 1994). The CATCH intervention is a large, multi-center trial including 96 schools and 8,000 students in four study centers across the United States. Classroom nutrition education was included as one component of this study. The process evaluation for CATCH, designed to assess program implementation and explain program effects, is diagrammed in Figure 2. The conceptual model used for designing this evaluation included teacher self-efficacy as one of the school staff characteristics that would presumably be enhanced by training activities and that would have an effect on “carrying out the CATCH intervention” (McGraw et al., 1994). The other staff characteristics included in this model were (1) support for CATCH objectives, (2) exposure to CATCH training, and (3) previous work experience. The researchers hypothesized that all of these characteristics would affect the completeness and accuracy of the teacher's implementation of CATCH and that the relationships among training, staff characteristics, and implementation would be reciprocal.
Figure 2. Conceptual model for process evaluation of CATCH (McGraw et al., 1994)

Training, confidence, and teacher practice in other content areas

In other content areas, some researchers have focused their studies on the relationship of teacher training to teacher self-efficacy or confidence for teaching that subject, and have identified a central role for self-efficacy in the implementation of desired curricula or strategies. For example, Sheldon and Halverson (1981) assessed changes in teachers’ confidence in their knowledge of science concepts and science teaching strategies as a measure of the impact of a televised in-service training. They used a concept inventory scale designed to measure the confidence teachers had in the use of concepts included in the training sessions. The structure of their study implied that teachers’ confidence in their own knowledge was seen as a mediating variable that influenced the impact of teacher training on changes in teaching behavior. After a series of five 30-minute
televised in-service training sessions, mean confidence scores for understanding science
corcepts improved among teachers in four of the six grades levels ($p < .05$), and the mean
confidence scores for understanding science teaching strategies improved in all grade
levels ($p < .05$).

Ernest (1989) outlined a model of cognitive structures related to teaching
mathematics. This model recognized teacher attitudes toward the subject and toward
teaching the subject, including confidence in the teacher’s own ability to teach
mathematics, as an important component in the model. He suggested that mathematical
knowledge would be expected to influence mathematical confidence “via the perceived
adequacy of the teacher’s knowledge” (p. 28). He also pointed out that attitudes toward
the subject itself would potentially influence attitudes about teaching the subject, which
in turn would influence the ethos of the mathematics classroom and therefore the
student’s perceptions of the subject. This model assumes that the subject will be taught,
as mathematics is usually a required subject.

Smylie (1988) proposed and tested a path model to assess the relationships among
personal teaching efficacy, certainty of practice, organizational contexts, and changed
teaching practices in teachers (Figure 3). He defined personal teaching efficacy as
“teachers’ perception of their own ability to influence student learning,” and certainty of
practice as “beliefs in their own technical competence, their certainty that their practice is
appropriate and potentially effective” (pp. 6-7). The teachers studied were all volunteers
for a staff development activity designed to improve teaching practice. Smylie’s model
proposed that teachers’ personal teaching efficacy would have a direct positive effect on
changes in their teaching practices as a result of the staff development. In addition, the
model proposed that the teachers’ certainty of practice would positively affect their
personal teaching efficacy and would therefore indirectly affect changes in their teaching
practices. He found that personal teaching efficacy was the most significant predictor of
change in practice among these teachers (standardized $\beta = .30, p < .01$), and certainty of practice was the most significant predictor of personal teaching efficacy ($\beta = .30, p < .01$). The only other significant ($p < .05$) path to change in teacher practice was from class size ($\beta = .26, p < .01$) and the only other significant path to personal teaching efficacy was from 'concentration of low achieving students' ($\beta = -.27, p < .01$). Smylie concluded that "...in this context of staff development, teachers' perceptions and beliefs about their own practice are the most significant predictors of individual change" (1988, p. 23).
Borchers, Shroyer, and Enochs (1992) applied the conclusions of Smylie's (1988) work and the construct of self-efficacy in their research on encouraging rural teachers to use computers for science education. They defined self-efficacy in relationship to teachers as "a teacher's confidence in his or her own ability to teach and to have students learn" (p. 384). Two sub-components of self-efficacy were assessed: (1) the teachers' beliefs in their ability to use computers for instruction, which they referred to as self-efficacy, and (2) the teachers' beliefs that computer instruction would enhance student learning, which they referred to as outcome expectancy belief. Through a year-long training program, teachers' self-efficacy, their beliefs in their ability to use computers for instruction, improved \( p < .01 \). Use of computers in teaching also increased \( p < .01 \), while teachers' outcome expectancies did not change. The researchers noted that changes in teaching practice appeared related to changes in self-efficacy. They cautioned, however, that they were not proposing a causal relationship but suggesting further research on the relationships among teacher behaviors and teacher efficacy beliefs.

Several theoretical models or proposals concerning the relationships among teacher training, confidence or self-efficacy, and practice have been reviewed in this section. These studies and commentaries clearly indicate the potential importance of teacher confidence in mediating a relationship between teacher training and instructional practice. In the field of nutrition education, however, such a mediated relationship has not been tested. From the literature reviewed in this chapter, potential structures can be proposed to explain the mechanism by which elementary teachers' backgrounds and training in nutrition affect their subsequent teaching of the subject, and how teacher confidence may play a role in this relationship.
Research Hypotheses and Structural Models

The present study was designed to investigate the structural relationship between teachers' backgrounds and the time they spend teaching nutrition. A review of research in this area led me to conclude that in the past 20 years, little progress has been made in understanding the relationships among these constructs. I did not find any studies that specifically attempted to elucidate these relationships, and related studies provided only spotty and incomplete information. Therefore, a structural analysis of the relationships among teachers' training, knowledge, beliefs, confidence, and their teaching of nutrition will advance knowledge in this area and provide guidance for the practice of nutrition education.

The models proposed are simpler and less comprehensive than the CATCH model (Figure 2) in that they are focused only on the teachers' backgrounds and especially their nutrition training as predictors of the outcome. By simplifying the elements investigated, the role of teacher confidence in mediating the relationship between training and time spent teaching may be clarified. These theoretical models are described here; their development and testing are described in later chapters.

The primary hypothesis to be tested is that the effect of nutrition training on time spent teaching is mediated by an increase in confidence, or self-efficacy, for teaching nutrition. This hypothesis was based on the role of self-efficacy as a determinant of behavior, as described by Bandura (1977), and the use of confidence as a mediating factor in changing teacher behavior, as described in the science education literature (Borchers et al., 1992; Sheldon & Halverson, 1981; Smylie, 1988).

The alternative hypothesis is that nutrition training exerts an effect on time spent teaching nutrition that is independent of the teacher's level of confidence. This hypothesis was based on the theoretical assumptions implicit in the nutrition and health education literature that nutrition training exerts a direct effect on the time spent teaching nutrition
In addition, both models assume (1) that nutrition knowledge indirectly influences the time spent teaching nutrition, through increasing teacher confidence, and (2) that beliefs about the importance of nutrition instruction directly influence time spent teaching nutrition. The two models that will be used to test these hypotheses are shown in Figures 4 and 5.
Figure 4. Structural model to test primary hypothesis. Straight lines depict hypothesized causal influences; curved lines depict estimated associations.

\( \beta \) (beta) = effect of endogenous construct on another endogenous construct.

\( \gamma \) (gamma) = effect of exogenous construct on endogenous construct.

\( \phi \) (phi) = correlation between two exogenous constructs.

\( \zeta \) (zeta) = error or unique variance in endogenous construct.
Figure 5. Structural model to test alternative hypothesis. Straight lines depict hypothesized causal influences; curved lines depict estimated associations.

$\beta$ (beta) = effect of endogenous construct on another endogenous construct.

$\gamma$ (gamma) = effect of exogenous construct on endogenous construct.

$\phi$ (phi) = correlation between two exogenous constructs.

$\zeta$ (zeta) = error or unique variance in endogenous construct.
CHAPTER 2
DEVELOPMENT OF THE STRUCTURAL MODELS

In order to test the hypotheses presented in the previous chapter, I selected an existing data set that included variables which could serve as measures of all of the constructs of interest. These data were collected as part of the 1990-92 Nutrition Education and Training (NET) Program needs assessment (Lai et al., 1994). I will describe the participants, instrument, and methods used in this needs assessment survey in the following sections.

One advantage of using this existing data set is that the respondents represented all elementary teachers in Hawai‘i. By using this sample, the analysis and hypothesis testing could be based on all of Hawai‘i’s elementary teachers, rather than just those teachers who volunteered for nutrition training. The conclusions that are drawn, then, should apply to all elementary teachers in the State.

Participants

The subjects for this study were the 324 Hawai‘i elementary teachers who were part of the statewide stratified random sample of teachers surveyed for the 1990-92 NET needs assessment (Lai et al., 1994). A sampling design for this overall study was created to replicate, as closely as possible, the sampling design for the 1980 NET Program Needs Assessment. The schools selected for the 1990-92 survey were the same schools that had been selected for the 1980 Needs Assessment, with exceptions only when the school no longer existed or grade levels covered by the school had changed. In those cases, the replacement schools were selected by choosing the school to which students who lived in the former school’s geographic area were most likely to be attending now (Lai et al., 1994).
The 1980 NET Needs Assessment sampling plan included 42 elementary schools statewide (Garza, McNamee, Myers, & Nafziger, 1979). In 1990-92, questionnaires were actually returned from teachers in 41 elementary schools, 37 of which were the same as those sampled in 1980 and 4 that were not listed in the sampling plan. I presume that these other schools were replacements for schools that had closed or changed the grade levels taught.

Questionnaires were sent or delivered to the principal of each school with a request that two teachers each from kindergarten, grade 1, grade 2, grade 3, and grade 5 complete the survey (Lai et al., 1994). A total of ten teachers in each school, then, should have been given a survey.

Surveys were anonymous and were coded with pre-stamped six-digit numbers for identification. The first three digits of the number was the Department of Education school code number, the fourth digit identified the type of survey (student, teacher, parent, school food service manager, or school nurse), and the last two digits represented the individual (Lai et al., 1994).

The overall teacher data set from the 1990-92 NET needs assessment included 558 elementary and secondary teachers. In order to select only elementary teachers, I examined the portion of the code number indicating school. If the code number represented an elementary school, all teachers from that school were retained in the sample. Thirty-nine of the school codes represented elementary schools, and all 314 individual records from those schools were included in the sample. If the code number represented an intermediate or high school, all teachers were excluded. Eight school codes represented combinations of elementary schools with intermediate or high schools. For these schools, I examined individual records and included teachers in the sample only if their responses to the questions about the grade level or subjects they taught were
appropriate. A total of ten teachers from two of these schools were included in the sample.

If instructions for distribution of the questionnaires were followed exactly, a total of 410 questionnaires would have been distributed to teachers in the 41 elementary schools. The response of 324 of these elementary teachers represents a 79% response rate.

**Instrumentation**

A wide range of information concerning nutrition knowledge, attitudes, and practices was collected from this statewide sample of elementary teachers in the 1990-92 Nutrition Education and Training (NET) Program needs assessment (Lai et al., 1994). Questions included in the survey were designed to gather essentially the same information that had been obtained in the 1980 needs assessment. However, some revisions were made in questions to reflect changes in the information needed or to meet space limitations. To reduce respondent burden, questionnaires were limited to 60 questions. Drafts of the teacher questionnaire were reviewed by three teachers as well as by evaluation staff members. Their comments and recommendations were incorporated into the final instruments (Lai et al., 1994).

A number of questions on the survey offered potential measures of the constructs of interest for the current study. Questions to be used in this analysis were initially selected based on face validity. That is, did the question appear to ask for information that would be closely related to one of the underlying constructs? Questions selected in this manner and the construct they were intended to measure are listed in Table 2. Possible responses and the numeric coding for each response are also listed. These numeric codes were used in the data analysis. These constructs and questions are further described in the following sections.
Table 2.

*Constructs Included in Structural Models and Questionnaire Items Selected to Measure those Constructs*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Variable</th>
<th>Questions and possible responses</th>
<th>Coding of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition knowledge</td>
<td>Kscore</td>
<td>Sum of correct responses to 24 knowledge items. See Table 3 for individual questions.</td>
<td>correct = 1 other = 0</td>
</tr>
<tr>
<td>Nutrition training</td>
<td>T1</td>
<td>Did your degree program include courses in food and nutrition science and/or nutrition education methods?</td>
<td>Yes = 1 No = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T2 During the past 5 years, how often have you attended training sessions in food and nutrition science and/or nutrition education methods?</td>
<td>None = 0 1-2 = 1 3-5 = 2 6-10 NA &gt;10 NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T3 Have you attended NET Program training sessions?</td>
<td>Yes = 1 No = 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T4 I usually get nutrition information from:</td>
<td>Newspapers, magazines, books, television, radio = 0 Classes, lectures, workshops, demonstrations = 1 Friends, family, children = 0 Doctors, nurses, nutritionists/dietitians, medical professionals = 0 School health specialist or resource teacher = 0</td>
</tr>
<tr>
<td>Belief it is important to</td>
<td>A5</td>
<td>The school should teach students how to select foods that are important for good health.</td>
<td>Strongly disagree = 0 Disagree = 1 Agree = 2 Strongly agree = 3</td>
</tr>
<tr>
<td>teach</td>
<td></td>
<td>A6 I set a good example selecting and eating foods that are important for good health.</td>
<td>Strongly disagree = 0 Disagree = 1 Agree = 2 Strongly agree = 3</td>
</tr>
</tbody>
</table>

*(table continued)*
### Table 2. (continued)

** Constructs Included in Structural Models and Questionnaire Items Selected to Measure those Constructs **

<table>
<thead>
<tr>
<th>Construct</th>
<th>Variable</th>
<th>Questions and possible responses</th>
<th>Coding of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belief it is important to teach nutrition, cont’d.</td>
<td>A7</td>
<td>There is a direct relationship between nutrition, health, and the quality of life.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly disagree</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disagree</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly agree</td>
<td>3</td>
</tr>
<tr>
<td>Students I teach need to learn about nutrition.</td>
<td>A8</td>
<td>Strongly disagree</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disagree</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly agree</td>
<td>3</td>
</tr>
<tr>
<td>I have received appropriate training to teach nutrition.</td>
<td>C9</td>
<td>Strongly disagree</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disagree</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agree</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly agree</td>
<td>3</td>
</tr>
<tr>
<td>When it comes to the area of nutrition:</td>
<td>C10</td>
<td>I do not understand the subject.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I have some idea but I am not sure about the subject.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I have a fair knowledge about the subject.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I understand fairly well but cannot explain it to other people.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I understand the subject well and can explain it to others.</td>
<td>4</td>
</tr>
<tr>
<td>About how often do you teach food and nutrition concepts?</td>
<td>Calc.</td>
<td>Number of hours per year calculated from these two variables</td>
<td></td>
</tr>
<tr>
<td>Time spent teaching nutrition</td>
<td>Time</td>
<td>Daily</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weekly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yearly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td>In the frequency indicated in question 3 (above), about how much time do you spend teaching food and nutrition concepts?</td>
<td></td>
<td>1 hr.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-3 hrs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-5 hrs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5 hrs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never</td>
<td></td>
</tr>
</tbody>
</table>
Exploratory factor analysis was used to determine the relationships among the items selected to measure several of the constructs (nutrition training, nutrition confidence, nutrition knowledge, and belief that nutrition is important). The factor analysis was conducted using the SAS factor procedure (SAS Institute, 1990), with a varimax rotation. Although four factors could have been retained by examination of the scree plot (Figure 6), the analysis was run with number of factors set to three, for two reasons. First, there were only three constructs of interest that were measured by more than one variable. Second, limiting the solution to three factors allowed a visual, three-dimensional representation of the solution to be created to assist in interpretation. I will present the results of the exploratory factor analysis in the sections describing the selection of variables for each pertinent construct.

Figure 6. Scree plot of the exploratory factor analysis for 11 variables.
Nutrition Knowledge

In the 1980 NET needs assessment, nutrition knowledge was measured based on questions related to specific nutrients, as the focus of nutrition education at that time was the prevention of nutrient deficiencies (Lai et al., 1994). In the decade from 1980 to 1990, the focus of nutrition education in the United States shifted to overall wellness, with concerns about dietary excesses as well as deficiencies. The 1990-92 NET needs assessment questionnaire included 24 questions designed to measure nutrition knowledge related to the *Dietary Guidelines for Americans* (U.S. Departments of Agriculture and Health and Human Services, 1990). Since their introduction in 1980, the Dietary Guidelines have served as a blueprint for the nutrition knowledge most individuals need to make healthful food selections. These 24 knowledge questions were therefore considered to be a representative measure of general nutrition knowledge.

Twenty of the nutrition knowledge questions were selected from two forms of a set of questions designed to measure knowledge about the Dietary Guidelines by IOX Assessment Associates (1988). These questions were developed by experienced test developers, utilizing guidance from nutrition experts. They were tested with small samples of individuals, revised, and then reviewed by specialists in nutrition education (IOX Assessment Associates, 1988). Several of the questions from this set that were selected for the NET needs assessment were adapted to make the foods mentioned more appropriate to Hawai‘i, such as substituting rice for bread. Four additional questions were developed by the NET needs assessment project staff from information in the *Dietary Guidelines for Americans* booklet (Lai et al., 1994; U.S. Departments of Agriculture and Health and Human Services, 1990). It appears that these questions were developed to assess knowledge of Dietary Guidelines concepts that were not covered in the IOX Assessment Associates questionnaires. Each knowledge question and its source are shown in Table 3.
Table 3.

**Nutrition Knowledge Questions, Questionnaire Item Numbers, Correct Responses, and Sources of Questions**

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question [correct response, true or false]</th>
<th>Source(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>Eating many different kinds of foods is healthy. [T]</td>
<td>Written by project staff</td>
</tr>
<tr>
<td>38</td>
<td>Being willing to try different foods is healthy. [T]</td>
<td>Written by project staff</td>
</tr>
<tr>
<td>39</td>
<td>Healthy weight management includes exercising regularly. [T]</td>
<td>Written by project staff</td>
</tr>
<tr>
<td>40</td>
<td>Reading food labels to find out how much fat, sugar, and sodium (salt) it has is healthy. [T]</td>
<td>Written by project staff</td>
</tr>
<tr>
<td>41</td>
<td>Chicken eaten without its skin has about the same amount of fat as chicken eaten with its skin. [F]</td>
<td>Form A</td>
</tr>
<tr>
<td>42</td>
<td>Broiled foods have more fat than fried foods. [F]</td>
<td>Form A</td>
</tr>
<tr>
<td>43</td>
<td>Most processed breakfast cereals like corn flakes have a lot of salt (sodium). [T]</td>
<td>Form A, wording modified</td>
</tr>
<tr>
<td>44</td>
<td>Eating whole grain foods like brown rice and whole wheat bread adds fiber to the diet. [T]</td>
<td>Form B, food choices adapted</td>
</tr>
<tr>
<td>45</td>
<td>Most fruit drinks like fruit punch, guava and passion-orange are low in sugar. [F]</td>
<td>Form B, food choices adapted</td>
</tr>
<tr>
<td>46</td>
<td>Honey has fewer calories than sugar. [F]</td>
<td>Form A</td>
</tr>
<tr>
<td>47</td>
<td>Eating foods that are high in saturated fats raises a person's chance of getting heart disease. [T]</td>
<td>Form B, wording modified</td>
</tr>
<tr>
<td>48</td>
<td>Apple juice has the same amount of fiber as a whole apple. [F]</td>
<td>Form A</td>
</tr>
<tr>
<td>49</td>
<td>Starchy foods such as corn, poi, rice, and bread are high in fat. [F]</td>
<td>Form A, food choices adapted</td>
</tr>
<tr>
<td>50</td>
<td>Chicken nuggets are much lower in fat than a hamburger. [F]</td>
<td>Form A</td>
</tr>
<tr>
<td>51</td>
<td>Most canned soups are high in sodium. [T]</td>
<td>Form A</td>
</tr>
<tr>
<td>52</td>
<td>Eating a lot of salt may raise a person's chance of getting high blood pressure. [T]</td>
<td>Form A</td>
</tr>
<tr>
<td>53</td>
<td>Fish sticks are usually low in fat. [F]</td>
<td>Form B, wording modified</td>
</tr>
<tr>
<td>54</td>
<td>Most people get too little salt in their diets. [F]</td>
<td>Form A, wording modified</td>
</tr>
</tbody>
</table>

*(table continued)*
Table 3. (continued)

Nutrition Knowledge Questions, Questionnaire Item Numbers, Correct Responses, and Sources of Questions

<table>
<thead>
<tr>
<th>Item #</th>
<th>Question [correct response, true or false]</th>
<th>Sourcea</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>Foods that are low in cholesterol are also low in fat. [F]</td>
<td>Form B</td>
</tr>
<tr>
<td>56</td>
<td>Being overweight raises a person's chance of getting high blood pressure. [T]</td>
<td>Form B</td>
</tr>
<tr>
<td>57</td>
<td>Ice cream and frozen yogurt usually have the same amount of fat. [F]</td>
<td>Form B</td>
</tr>
<tr>
<td>58</td>
<td>Most people should take a multivitamin every day. [F]</td>
<td>Form B</td>
</tr>
<tr>
<td>59</td>
<td>Brown rice has about the same amount of fiber as white rice. [F]</td>
<td>Form A, food choices adapted</td>
</tr>
<tr>
<td>60</td>
<td>Portuguese sausage is high in fat. [T]</td>
<td>Form A, food choices adapted</td>
</tr>
</tbody>
</table>


I used the K–R 20 measure of internal consistency to determine the reliability of the scale composed of the sum of correct responses on the nutrition knowledge items. The K–R 20 was run on data sets that included all teachers (N=558) and parents of 5th grade students (N=734), in addition to the data set of elementary teachers only (N=324). I employed Cody and Smith's (1991) formula for computing K–R 20 on a SAS data set (p. 327). The K–R 20 coefficients were 0.56 for the elementary teacher sample, 0.76 for the total teacher sample, and 0.84 for the parent sample (Table 4). The higher K–R 20 values for the total teacher and parent samples probably represent the greater variance in their scores. The test of internal consistency was used in this study to determine if the 24 items could be considered to represent a single factor of nutrition knowledge. Given the
homogeneity of the elementary teacher group and the low variance in their scores in comparison to variance of parent scores, the internal consistency reliability was considered to be acceptable. The 24 items were considered to represent a single factor of "nutrition knowledge." For the purposes of the current study, then, the construct of nutrition knowledge was operationally defined as a construct measured by the total score on these 24 items, with higher scores representing more "nutrition knowledge."

Table 4.

Descriptive Statistics and K-R 20 Reliability Coefficients for Three Groups of Respondents to 24 Nutrition Knowledge Questions

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean score</th>
<th>Standard Deviation</th>
<th>Minimum score</th>
<th>Maximum score</th>
<th>K-R 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents</td>
<td>734</td>
<td>15.84</td>
<td>4.73</td>
<td>0</td>
<td>24</td>
<td>0.84</td>
</tr>
<tr>
<td>Teachers</td>
<td>558</td>
<td>20.18</td>
<td>3.04</td>
<td>0</td>
<td>24</td>
<td>0.76</td>
</tr>
<tr>
<td>Elementary teachers only</td>
<td>324</td>
<td>20.37</td>
<td>2.25</td>
<td>12</td>
<td>24</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Although the K–R 20 coefficients were considered acceptable for the purposes of defining a single construct of "nutrition knowledge," the low variance of scores among the elementary teachers indicated that this scale would probably not be an extremely accurate measure of the construct for this sample. The square root of the K-R 20 internal consistency coefficient was assumed to be the maximum possible correlation between the construct "nutrition knowledge" and the nutrition knowledge score, based on the definition that the correlation between observed and true score, the index of reliability, is equal to the square root of the reliability coefficient (Gulliksen, 1987, p. 37). Therefore, the square root of the reliability coefficient for the elementary teacher sample was used as an initial estimate for the path coefficient for knowledge in the structural equations analysis (See Chapter 3).
**Nutrition Training**

Four questions on the questionnaire related in some way to a teacher's previous training in nutrition. The first three of these were quite obviously related to training in nutrition, as they asked about attendance at college or university nutrition courses (Question T1), in-service training session in nutrition (Question T2), or NET-sponsored training sessions (Question T3), respectively. The fourth question asked teachers about the usual source of their nutrition information (Question T4). A response of "classes, lectures, workshops, demonstrations" was considered to be a sign that the teacher was likely to have received more nutrition training than other teachers who reported mass media sources, friends, or health professionals as the usual sources of their nutrition information.

Approximately one-third (32%) of the elementary teachers in the sample reported that their degree programs included courses in food and nutritional science and/or nutrition education methods. Approximately one-fourth (28%) reported that they had attended at least one training session in the past five years, but less than 3% reported having attended more than two. About 10% reported that they had attended a NET program training session. Only 17% of the elementary teachers selected the option "classes, lectures, workshops, demonstrations" as their usual source of nutrition information. Most (64%) of the teachers selected "newspaper, magazines, books, television radio" as their usual source of information.

Nutrition training was originally defined as a construct that was measured by the observed responses to the four survey questions on training. However, the focus of the present study was more specifically on the relationship of in-service training to teaching of nutrition and one of these variables was concerned with nutrition classes taken in college. The results of exploratory factor analysis (Table 5 and Figure 7) indicated that nutrition classes taken in college (pre-service training, variable T1) did not load as highly
on factor 3, which I have titled "training," as did the other three variables selected to measure this construct. In order to retain a focus on in-service training only, the variable measuring pre-service training was dropped from the structural analysis. The construct of nutrition training was therefore defined as in-service training in nutrition as measured by the observed responses to three survey questions on in-service training.

Table 5.

*Rotated Factor Pattern for Variables Measuring Teacher Beliefs, Training, Confidence, and Knowledge (varimax rotation, number of factors set to 3)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor 1 “Beliefs”</th>
<th>Factor 2 “Confidence”</th>
<th>Factor 3 “Training”</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>-0.08</td>
<td>0.31</td>
<td>0.24</td>
</tr>
<tr>
<td>T2</td>
<td>-0.00</td>
<td>0.06</td>
<td>0.55</td>
</tr>
<tr>
<td>T3</td>
<td>0.04</td>
<td>0.15</td>
<td>0.33</td>
</tr>
<tr>
<td>T4</td>
<td>0.09</td>
<td>0.03</td>
<td>0.45</td>
</tr>
<tr>
<td>A5</td>
<td>0.54</td>
<td>0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>A6</td>
<td>0.33</td>
<td>0.38</td>
<td>0.03</td>
</tr>
<tr>
<td>A7</td>
<td>0.46</td>
<td>0.11</td>
<td>-0.01</td>
</tr>
<tr>
<td>A8</td>
<td>0.60</td>
<td>-0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>C9</td>
<td>-0.06</td>
<td>0.52</td>
<td>0.35</td>
</tr>
<tr>
<td>C10</td>
<td>0.14</td>
<td>0.55</td>
<td>0.07</td>
</tr>
<tr>
<td>KSCORE (K)</td>
<td>0.14</td>
<td>0.27</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Figure 7. Three-dimensional representation of factor pattern from exploratory factor analysis, varimax rotation, number of factors set to 3.

T1 Had preservice nutrition training
T2 Had in-service nutrition training
T3 Had NET training
T4 Classes/workshops are main source nutrition information
A5 Believe school should teach
A6 Believe I set a good example in eating right
A7 Believe there is a direct relationship of nutrition to health
A8 Believe that students need to learn
C9 Believe I have appropriate training to teach nutrition
C10 Self-rating of nutrition
K Nutrition knowledge
Belief that it is Important to Teach Nutrition

Four questions on the questionnaire were initially selected as measures of the belief that teaching nutrition is important. All of the questions asked for a response of strongly agree, agree, disagree, or strongly disagree. Two questions were related to the importance of nutrition as a subject: “Students I teach need to learn about nutrition” (Question A8) and “There is a direct relationship between nutrition, health, and the quality of life” (Question A7). One question was related to the school’s responsibility for teaching nutrition: “The school should teach students how to select foods that are important for good health” (Question A5). The final question was related to how these teachers view their own nutrition practices: “I set a good example selecting and eating foods that are important for good health” (Question A6). I recognized that the last question may not have been as directly related to beliefs about teaching nutrition as the other three. It was initially included because the variance of the teachers’ responses on the first three questions was small (Table 6).

Table 6.

Responses of Teachers to Questions about the Importance of Teaching Nutrition (N=324)

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly agree (%)</th>
<th>Agree (%)</th>
<th>Disagree (%)</th>
<th>Strongly disagree (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The school should teach students how to select foods that are important</td>
<td>42</td>
<td>56</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>for good health. [A5]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I set a good example selecting and eating foods that are important for</td>
<td>22</td>
<td>65</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>good health. [A6]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is a direct relationship between nutrition, health, and the quality</td>
<td>81</td>
<td>19</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>of life. [A7]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students I teach need to learn about nutrition. [A8]</td>
<td>54</td>
<td>45</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
The results of exploratory factor analysis (See Table 5 and Figure 6) indicated that the question about setting a good example (A6) did not load as highly on factor 2, which I titled "belief," as did the other three variables selected to measure this construct. Since it also did not appear to have face validity for this construct, the question on setting a good example was dropped from the structural analysis. "Belief in importance of teaching nutrition" can be operationally defined, then, as a construct measured by the observed responses to the three survey questions on the teachers' beliefs in the importance of teaching nutrition.

**Teachers’ Confidence that they can Teach Nutrition**

Two questions on the questionnaire appeared to assess teachers’ confidence that they could teach nutrition. The first question was related to the teachers’ perceptions that they had appropriate training in this area (Question C9). The second asked teachers to rate their own nutrition knowledge (Question C10). Response options for this self-rating of knowledge included the ability to explain nutrition concepts to others (Table 7).

Question C10, self-rating of knowledge, is similar to a measure that has been used in assessing teachers’ confidence in their ability to understand and teach science after inservice training (Sheldon & Halverson, 1981). The Science Curriculum Improvement Study (SCIS) Concept Inventory was used to measure the gain in confidence in using the terms and concepts presented. Teachers were asked to rate their level of confidence as "fully knowledgeable enough to design and teach a series of lessons using the topic," "know how to define and explain the meaning adequately, but could not use it in designing and teaching a series of lessons," "have only a vague, superficial, and limited understanding," or "have poor or no understanding at all" (Sheldon & Halverson, 1981, p. 408, italics in original). These responses are similar to the possible responses allowed on the NET survey, as listed in Table 7.
Responses of Hawai‘i elementary teachers to the two questions related to confidence are shown in Table 7. The elementary teachers in this sample were about evenly split between those that felt they had appropriate training to teach nutrition (47%) and those that did not believe this (54%). The majority (60%) of the teachers rated their own knowledge of nutrition as fair. About one-fourth (26%), though, felt that they understood nutrition well and could explain it to others.

The exploratory factor analysis confirmed that these two questions were related (Table 5 and Figure 6). They both loaded strongly on a factor that was titled “confidence.” “Confidence for teaching nutrition” was operationally defined, then, as a construct measured by the observed responses to the two questions on teacher confidence.

Table 7.

Responses of Teachers to Questions about their Confidence for Teaching Nutrition (N=324)

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>% Giving response</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have received appropriate training</td>
<td>Strongly disagree</td>
<td>12</td>
</tr>
<tr>
<td>to teach nutrition.</td>
<td>Disagree</td>
<td>42</td>
</tr>
<tr>
<td>[C9]</td>
<td>Agree</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Strongly agree</td>
<td>8</td>
</tr>
<tr>
<td>When it comes to the area of nutrition:</td>
<td>I do not understand the subject.</td>
<td>1</td>
</tr>
<tr>
<td>[C10]</td>
<td>I have some idea but I am not sure about the subject.</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>I have a fair knowledge about the subject.</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>I understand fairly well but cannot explain it to other people.</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>I understand the subject well and can explain it to others.</td>
<td>26</td>
</tr>
</tbody>
</table>
Time Spent Teaching Nutrition

Two questions on the NET needs assessment were related to the time teachers spent teaching nutrition in their classrooms. One asked teachers to report how frequently they taught nutrition, and the second asked how much time they spent teaching nutrition, in relation to the frequency they had reported. In order to estimate the total amount of time a teacher spent on nutrition, I developed an algorithm to convert each teacher’s responses to these two questions into the number of hours per year nutrition was taught (Table 8).

Conservative estimates of time were made in every case. For example, if a teacher reported teaching “4-5 hours” of nutrition on a yearly basis, the time spent teaching was estimated to be 4 hours per year. If teacher reported teaching “>5 hours” of nutrition on a monthly basis, the time spent teaching was estimated to be five hours per month for nine months of school, or 45 hours per year. If teacher reported teaching “2-3 hours” of nutrition on a weekly basis, the time spent teaching was estimated to be two hours per week for 35 weeks of school, or 70 hours per year. The choices made by teachers on the two questionnaire items and the result of the hours per year calculation are shown in Table 8. Two responses of one hour per day and greater than 5 hours per day of nutrition instruction were considered to be errors, and the respondents were eliminated from the analysis.

The discrete numbers that resulted from the calculation of “hours per year” teaching nutrition represent a function that should be a continuous variable. However, the data set only allowed for representation of these data in discrete steps. An estimate was made of how well these stepped numbers could represent a true continuous variable measuring the time spent teaching nutrition, using the growth function incorporated into the Excel program (Microsoft Corporation, 1992).
Table 8.

*Responses of Teachers to Questions about Time Spent Teaching Nutrition and Calculation of Estimated Actual Time Spent Teaching Nutrition (N = 315\(^a\))*

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Time within frequency</th>
<th>Calculation</th>
<th>Hours per Year</th>
<th>Number of teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Yearly</td>
<td>1 hour</td>
<td>1 x 1</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>2-3 hours</td>
<td>1 x 2</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>4-5 hours</td>
<td>1 x 4</td>
<td>4</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>&gt;5 hours</td>
<td>1 x 5</td>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td>Monthly</td>
<td>1 hour</td>
<td>9 x 1</td>
<td>9</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>2-3 hours</td>
<td>9 x 2</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4-5 hours</td>
<td>9 x 4</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>&gt;5 hours</td>
<td>9 x 5</td>
<td>45</td>
<td>6</td>
</tr>
<tr>
<td>Weekly</td>
<td>1 hour</td>
<td>35 x 1</td>
<td>35</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>2-3 hours</td>
<td>35 x 2</td>
<td>70</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4-5 hours</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;5 hours</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Daily</td>
<td>1 hour</td>
<td>176 x 1</td>
<td>176</td>
<td>1(^b)</td>
</tr>
<tr>
<td></td>
<td>2-3 hours</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4-5 hours</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;5 hours</td>
<td>-</td>
<td>1(^c)</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) There were 9 missing responses to one or both questionnaire items.

\(^b\) I considered this response to be an outlier or in error, possibly because an answer of less than 1 hour per day was not a possible option for a respondent who had answered “daily” to the previous question. It was used in fitting the growth-function curve but coded as ‘missing’ for the structural analysis.

\(^c\) This response was considered to be in error. It was coded as ‘missing.’
The growth function fits an exponential curve to a set of known data points. It then
returns an array of points along the curve, one point for each of the actual data points. I
used this function to create an estimate of the possible actual time teaching nutrition for
each calculated time. Cumulative frequency distributions for the calculated responses and
the continuous estimate are shown in Figure 8. This continuous estimate was used to
determine how closely the stepped data points could potentially correlate with the
estimated actual values. I calculated the correlation between the two sets of numbers, also
using the Excel program (Microsoft Corporation, 1992). The correlation between the
calculated time and the estimated actual time was \( r = .88 \). This correlation coefficient was
assumed to be the maximum possible correlation between the construct “time teaching
nutrition” and the calculated variable used to estimate this construct. Therefore, the
correlation coefficient was used as an initial estimate for the path coefficient for time in
the structural equations analysis (See Chapter 3).

\[ \text{Figure 8. Cumulative frequency distributions for the calculated responses and the continuous estimate of time spent teaching nutrition.} \]
The Structural Models

Two theoretical structural models were proposed (Figures 3 and 4, Chapter 1) to explore how nutrition training may be related to the time elementary teachers spend teaching nutrition. The primary hypothesis to be tested was that the effect of nutrition training on the time elementary teachers spend teaching is mediated by an increase in their confidence, or self-efficacy, for teaching nutrition. The alternative hypothesis was that nutrition training exerts a direct effect on the time spent teaching nutrition.

This chapter has described the selection of observed variables from an existing data set to be used as measures of each of the constructs in these two theoretical models. The variables selected for inclusion into the structural models, as described above, were as follows:

- To measure the construct “Knowledge,” the score on the 24-item knowledge test (Kscore);
- To measure the construct “Training,” having attended in-service training sessions in nutrition (Question T2), having attended NET-sponsored training sessions (Question T3), and usual source of nutrition information being “classes, lectures, workshops, demonstrations” (Question T4);
- To measure the construct “Belief,” the teachers’ ratings of the importance of teaching nutrition to their students (Question A8), the relationship between nutrition, health, and the quality of life (Question A7), and the school’s responsibility for teaching nutrition (Question A5);
- To measure the construct “Confidence,” the teachers’ perceptions that they had appropriate training in this area (Question C9) and the teachers’ rating of their own nutrition knowledge (Question C10);
- To measure the construct “Time,” the calculation of the number of hours per year nutrition was taught (Calc. Time).
The means and standard deviations for the variables entered into the structural analysis are presented in Table 9. The correlations among all of the variables entered into the structural analysis are presented in Table 10. In the next chapter I will describe the methods used to test the fit of these structural models to the observed data, using these variables, and the results of these tests.

Table 9.

Descriptive Statistics for Variables entered into Structural Analyses (N=313)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>0.31</td>
<td>0.52</td>
</tr>
<tr>
<td>T3</td>
<td>0.09</td>
<td>0.29</td>
</tr>
<tr>
<td>T4</td>
<td>0.17</td>
<td>0.37</td>
</tr>
<tr>
<td>A5</td>
<td>2.38</td>
<td>0.55</td>
</tr>
<tr>
<td>A7</td>
<td>2.81</td>
<td>0.39</td>
</tr>
<tr>
<td>A8</td>
<td>2.53</td>
<td>0.52</td>
</tr>
<tr>
<td>C9</td>
<td>1.41</td>
<td>0.80</td>
</tr>
<tr>
<td>C10</td>
<td>2.52</td>
<td>0.96</td>
</tr>
<tr>
<td>Kscore</td>
<td>20.41</td>
<td>2.27</td>
</tr>
<tr>
<td>Calc. Time</td>
<td>14.29</td>
<td>14.19</td>
</tr>
</tbody>
</table>
Table 10.

Correlation Coefficients between Variables entered into Structural Analyses (N=313)

<table>
<thead>
<tr>
<th>Variable</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>A5</th>
<th>A7</th>
<th>A8</th>
<th>C9</th>
<th>C10</th>
<th>Kscore</th>
<th>Calc. Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td></td>
<td>.28***</td>
<td>.33***</td>
<td>.02</td>
<td>.01</td>
<td>-.00</td>
<td>.25***</td>
<td>.07</td>
<td>.03</td>
<td>.20***</td>
</tr>
<tr>
<td>T3</td>
<td></td>
<td>.12*</td>
<td>.00</td>
<td>.01</td>
<td>.05</td>
<td>.18**</td>
<td>.16**</td>
<td>.08</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td></td>
<td>.10</td>
<td>.04</td>
<td>.05</td>
<td>.18**</td>
<td>.03</td>
<td>.05</td>
<td></td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td></td>
<td></td>
<td>.24***</td>
<td>.43***</td>
<td>.10</td>
<td>.11</td>
<td>.09</td>
<td></td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>A7</td>
<td></td>
<td></td>
<td>.33***</td>
<td>.03</td>
<td>.14*</td>
<td>.10</td>
<td>.07</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A8</td>
<td></td>
<td></td>
<td></td>
<td>-.02</td>
<td>.08</td>
<td>.07</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.34***</td>
<td>.13*</td>
<td>.24***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.22***</td>
<td>.15**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kscore</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calc. Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001
CHAPTER 3
TESTING THE STRUCTURAL MODELS

The relationships among teachers' nutrition training, knowledge, beliefs, confidence, and the time they spend teaching nutrition were estimated using two possible structural models. The difference between the two models was that in the primary model it was hypothesized that teachers who had received nutrition training would feel more confident in their ability to teach nutrition, and because of that increased confidence, would spend more time teaching nutrition. The alternative model made no such supposition about the role of confidence as a mediator between nutrition training and time spent teaching nutrition, and assumed that both training and confidence directly and independently influenced the time spent teaching nutrition.

The analysis of these two structural models was completed using the CALIS (Covariance Analysis of Linear Structural Equations) procedure of the SAS program (SAS Institute, 1990). CALIS uses covariance structure analysis to provide estimates of parameters and tests of fit for linear structural equation models. It performs analyses very similar to the more familiar LISREL program, which uses SPSS data sets (Jöreskog & Sörbom, 1990; Nunnally & Bernstein, 1994, p. 147). SAS input statements for the models that were tested are provided in the Appendix.

Analysis of Covariance Structures (ACS)

An analysis of covariance structures (ACS) technique was chosen to test these hypothesized models for several reasons. First, the hypothesized relationships to be tested in this study were between theoretical constructs that are not directly measurable. These constructs were measured by observed variables that served as proxies for them. ACS techniques provide a procedure for estimating the hypothesized relationships among
factors and do so in a way that preserves the distinction between the concepts of interest and the observed variables that are used to measure these concepts (Hayduk, 1987, p. xiii; Loehlin, 1992, pp. 48-53).

Second, ACS techniques do not assume that the concepts of interest are perfectly measured by questionnaire items or the scales derived from them. Rather, they use confirmatory factor analysis to create factor scores for the underlying constructs, based on the values of the measured variables. Each measured variable is seen as an expression of one underlying construct of interest. Through the ACS solution process, a factor loading coefficient ($\lambda$-lambda) is established for each construct-variable pair. An error term ($\delta$-delta) is also established for each variable to represent the unique variance in that variable that does not reflect variance in the underlying construct. Although each variable is assumed to measure only one construct, each construct can be, and usually is, measured by more than one variable. When only one variable is used to measure a construct, an initial estimate of $\lambda$ needs to be provided by the researcher. For the constructs of knowledge and time, which were measured by only one variable in the present study, the initial estimates used were those described in Chapter 2. The confirmatory factor analysis portion of the primary model for this study is illustrated in Figure 8.

Third, an ACS technique was considered appropriate for the current study because the hypotheses of interest for this study are causal in a broad sense, as defined by Loehlin (1992). Loehlin described cause in path diagram as "the assumption that a change in the variable at the tail of the arrow will result in a change in the variable at the head of the arrow, all else being equal" (p. 4). Using causal paths allows researchers to make and test hypotheses that suggest a direction of influence. ACS has been widely used to examine possible causal relationships among constructs in a variety of non-experimental research. While use of the terms "cause" or "causal" is common in ACS models, researchers recognize the possibility that the true underlying cause is not represented in the model of
Figure 9. Confirmatory factor analysis portion of hypothesized models of the relationships of teacher background to time spent teaching nutrition. Circles represent constructs, boxes represent variables. See Table 2, Chapter 2, for definition of each variable. Straight lines depict hypothesized causal influences.

\( \lambda \) = effect of construct on measured variable.

\( \delta \) = unique (error) variance in measured variable.

Covariances among constructs (\( \phi \)-phi) are not shown.
interest (Cliff, 1983; Loehlin, 1992, p. 228). Even with the restriction that ultimate cause may be external to the model, causation cannot be proven. Rather, models are tested to determine the extent to which the causal inferences implied by the model are consistent with the data. If the theoretical relationships cannot be represented by the data, then revisions in the theory are needed. Even if the theoretical relationships can be represented by the data, the researcher cannot conclude that the model has been “proven true.” An infinite number of other, untested models could provide alternative explanations for the covariances seen in the data (Bollen, 1989, p. 38-39).

In ACS, hypothesized causal relationships among the constructs of interest are specified by the researcher. The solution process searches for the best regression coefficients to assign to each hypothesized relationship among the constructs. Constructs in the model are identified as either endogenous or exogenous. An endogenous construct is one that is determined by other constructs within the model, while an exogenous construct is not determined by other constructs within the model. An exogenous construct’s “causal sources lie external to the path diagram” (Loehlin, 1992, p. 4). In the current study, knowledge, training, and beliefs are exogenous constructs, while confidence and time are endogenous constructs. Causal paths may be specified from exogenous to endogenous constructs (path coefficient is \( \gamma [\text{gamma}] \)) or from one endogenous construct to another (path coefficient is \( \beta [\text{beta}] \)). An error term is also established for each endogenous construct to represent the unique variance in that construct that does not reflect variance in other constructs included in the model. Exogenous constructs may be allowed to correlate with each other, as determined by the hypotheses being tested. The causal, correlational, and error paths in a model were illustrated in Figures 4 and 5 (Chapter 2). The method used to estimate path coefficients for the hypothesized models in this study was maximum likelihood estimation, which I will describe more fully in the next section.
Maximum Likelihood Estimation

In the current study, I used a maximum likelihood estimation (MLE) technique to estimate the fit of the specified theoretical models to the actual data. This technique seeks to minimize discrepancies between the actual and the model-implied variances and covariances among observed variables. A matrix (S) of actual variances and covariances for the sample is calculated from the input data set. A set of coefficients for the paths (λ, γ, β, and φ) and error terms in the specified model are calculated, based on the variances and covariances observed in the sample. The computed path coefficients and error terms represent the values for these relationships in the total population, assuming relationships are as specified in the model. A second matrix (Σ) of assumed population variances and covariances among the observed variables is calculated from the estimated path coefficients and error terms. Deviations between the observed variances and covariances (S) and the population estimates (Σ) are seen as sampling fluctuations. The principle of MLE is to minimize the amount of deviation that needs to be attributed to sampling fluctuation, and therefore select the set of population coefficients that have the maximum likelihood of being true given the observed sample data. Comparing the closeness of the model’s predicated variances and covariances (Σ) to observed reality (S) is the fundamental basis for testing a given model’s adequacy (Hayduk, 1987).

The process of MLE is as follows. Initial path coefficients and error terms are selected, and the discrepancy between S and Σ is evaluated. Iterative modifications in the coefficients and error terms are made to attempt to minimize the deviations. When the value of the discrepancy between S and Σ has been minimized, the resulting coefficients are those with the maximum likelihood of representing the true population values for these coefficients, given the constraints of the particular model.
Path Estimates for the Confirmatory Factor Analysis Model

Maximum likelihood estimation of the confirmatory factor analysis model shown in Figure 9 was performed using CALIS (SAS Institute, 1990). Covariance was allowed among all constructs. The solution converged in 9 iterations. The resulting model chi-square ($\chi^2$) was 37.91 ($27, N = 313$), $p = .08$, indicating that the discrepancy between the model ($\Sigma$) and the actual data ($S$) was small enough to be attributed to sampling fluctuations. The use of $\chi^2$ to test model fit will be described more fully in a following section. The $\lambda$ estimates for all observed variable-construct pairs are shown in Table 11. All of the $\lambda$ estimates had $t$ values above the critical value ($p < .001$), indicating that the null hypothesis of a zero parameter could be rejected (Hayduk, 1987, p. 174).

Table 11.

Standardized Factor Loading Coefficients ($\lambda$) and Error Estimates ($\gamma$) for each Construct-variable Pair in the Confirmatory Factor Analysis Model

<table>
<thead>
<tr>
<th>Construct-variable pairs</th>
<th>$\lambda$</th>
<th>$\gamma$</th>
<th>$t$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training—T2</td>
<td>0.77</td>
<td>0.10</td>
<td>7.50***</td>
</tr>
<tr>
<td>Training—T3</td>
<td>0.36</td>
<td>0.07</td>
<td>4.92***</td>
</tr>
<tr>
<td>Training—T4</td>
<td>0.42</td>
<td>0.08</td>
<td>5.52***</td>
</tr>
<tr>
<td>Belief—A5</td>
<td>0.59</td>
<td>0.08</td>
<td>7.68***</td>
</tr>
<tr>
<td>Belief—A7</td>
<td>0.45</td>
<td>0.07</td>
<td>6.46***</td>
</tr>
<tr>
<td>Belief—A8</td>
<td>0.73</td>
<td>0.08</td>
<td>8.59***</td>
</tr>
<tr>
<td>Confidence—C9</td>
<td>0.69</td>
<td>0.09</td>
<td>7.70***</td>
</tr>
<tr>
<td>Confidence—C10</td>
<td>0.49</td>
<td>0.08</td>
<td>6.55***</td>
</tr>
<tr>
<td>Knowledge—Kscore</td>
<td>0.75$^a$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time—Calc. time</td>
<td>0.88$^a$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^a$ Values determined by researcher.

*** $p < .001$
In CALIS, the statistical significance of causal or correlational paths are determined by the $t$ value. $t$ values are coefficient estimates divided by the standard error. The $t$ value is determined from a large sample $t$-test of a null hypothesis that the path coefficient is zero in the population. $t$ values over 1.96 represent a $p < .05$, over 2.58 represent a $p < .01$, and over 3.29 represent a $p < .001$ (Hatcher, 1994, p. 295).

Covariances ($\phi$) among the constructs, standard errors, and $t$ values for the covariance estimates are shown in Table 12. Only the covariances between confidence and time teaching ($p < .001$), training and time teaching ($p < .01$), knowledge and confidence ($p < .001$), and confidence and training ($p < .001$) had $t$ values above the critical value, indicating that the null hypothesis of no covariance could be rejected (Hatcher, 1994, p. 295; Hayduk, 1987, p. 174).

Table 12.

\textit{Covariances among Constructs from Confirmatory Factor Analysis}

<table>
<thead>
<tr>
<th>Construct pairs</th>
<th>$\phi$ Estimate</th>
<th>Standard error</th>
<th>$t$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge—Training</td>
<td>0.08</td>
<td>0.09</td>
<td>0.81</td>
</tr>
<tr>
<td>Knowledge—Belief</td>
<td>0.18</td>
<td>0.09</td>
<td>1.91</td>
</tr>
<tr>
<td>Knowledge—Confidence</td>
<td>0.35</td>
<td>0.10</td>
<td>3.40***</td>
</tr>
<tr>
<td>Knowledge—Time teaching</td>
<td>-0.09</td>
<td>0.09</td>
<td>-1.06</td>
</tr>
<tr>
<td>Training—Belief</td>
<td>0.05</td>
<td>0.09</td>
<td>0.58</td>
</tr>
<tr>
<td>Training—Confidence</td>
<td>0.44</td>
<td>0.10</td>
<td>4.61***</td>
</tr>
<tr>
<td>Training—Time teaching</td>
<td>0.25</td>
<td>0.08</td>
<td>3.02**</td>
</tr>
<tr>
<td>Belief—Confidence</td>
<td>0.13</td>
<td>0.09</td>
<td>1.36</td>
</tr>
<tr>
<td>Belief—Time teaching</td>
<td>0.10</td>
<td>0.08</td>
<td>1.23</td>
</tr>
<tr>
<td>Confidence—Time teaching</td>
<td>0.39</td>
<td>0.09</td>
<td>4.43***</td>
</tr>
</tbody>
</table>

**$p < .01$  ***$p < .001$
Path Estimates for Primary and Alternative Models

Since the null hypothesis for all of the variable-construct pairs could be rejected through confirmatory factor analysis, structural analysis of the primary and alternative models was conducted as planned. Maximum likelihood solutions for the primary and alternative models converged in five and six iterations, respectively. As with the confirmatory factor analysis model, the $\lambda$ estimates for all observed variables had $t$ values that allowed the null hypothesis to be rejected ($p < .001$). Standardized path coefficients for the primary and alternate models are shown in Figures 10 and 11. The null hypothesis could be rejected for the following paths in the primary model: confidence to time ($p < .01$), training to confidence ($p < .01$), and knowledge to confidence ($p < .05$). The null hypothesis could be rejected for the following paths in the alternate model: confidence to time ($p < .01$), training to time ($p < .05$), and knowledge to confidence ($p < .01$).

Table 13 lists the percent of variance explained ($R^2$) for the observed variables and endogenous constructs. In the alternative model, the $R^2$ for the variable $T2$ exceeded 1.00, suggesting that there may be a problem with the fit of the model. In the primary model, the $R^2$ for the construct time was .12, and for confidence .28. In the alternative model, the $R^2$ for the construct time was .10, and for confidence .16. These $R^2$ values indicate that only a small portion of the variance in the time spent teaching nutrition and a teacher's confidence for teaching nutrition can be attributed to variance in the variables within these models. However, these $R^2$ estimates may well be realistic estimates of the maximum amounts of variance in time teaching and confidence for teaching nutrition that can potentially be influenced by the variables included in these models.
Figure 10. Standardized path coefficients for the primary model.

**p < .01  *p < .05

Figure 11. Standardized path coefficients for the alternative model.

**p < .01  *p < .05
Table 13.

Percent of Variance Explained ($R^2$) for the Observed Variables and Endogenous Constructs in Primary and Alternative Models

<table>
<thead>
<tr>
<th>Variable or construct</th>
<th>Primary Model $R^2$</th>
<th>Alternative Model $R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>.53</td>
<td>1.19</td>
</tr>
<tr>
<td>T3</td>
<td>.14</td>
<td>.06</td>
</tr>
<tr>
<td>T4</td>
<td>.19</td>
<td>.09</td>
</tr>
<tr>
<td>A5</td>
<td>.33</td>
<td>.33</td>
</tr>
<tr>
<td>A7</td>
<td>.20</td>
<td>.20</td>
</tr>
<tr>
<td>A8</td>
<td>.55</td>
<td>.55</td>
</tr>
<tr>
<td>C9</td>
<td>.56</td>
<td>.29</td>
</tr>
<tr>
<td>C10</td>
<td>.20</td>
<td>.42</td>
</tr>
<tr>
<td>Kscore</td>
<td>.56</td>
<td>.55</td>
</tr>
<tr>
<td>Calc. Time</td>
<td>.88</td>
<td>.86</td>
</tr>
<tr>
<td>Time</td>
<td>.12</td>
<td>.10</td>
</tr>
<tr>
<td>Confidence</td>
<td>.28</td>
<td>.16</td>
</tr>
</tbody>
</table>

Chi-square Test of Model Fit

The primary method used in this study to test the fit of the two alternative hypothetical models to actual data was chi-square ($\chi^2$). Additional indices of model fit were also examined and will be discussed in a following section.

ACS techniques allow for the testing of alternative theoretical models to determine the model that is more likely describing the true relationships among the constructs of interest, based on the observed relationships among measured variables. While a close fit of a particular data set to a hypothesized model does not prove that the model is the best explanation for the observed relationships among the data points, a poor fit indicates that the model is not a good explanation for these observed relationships.

The $\chi^2$ test of model fit relies on a comparison of $\Sigma$ to $S$. A larger remaining discrepancy between $\Sigma$ and $S$ after maximum likelihood estimation results in a larger $\chi^2$. 
A large \( \chi^2 \) with a small probability (usually set at \( p < .05 \)) indicates that the amount of discrepancy between the model (\( \Sigma \)) and the actual data (\( S \)) is too large to be well explained only by sampling fluctuations. In the case of model fitting, rejecting the null hypothesis rejects the hypothesis that the model and the data represent the same population values. Alternatively, a small \( \chi^2 \) with a high probability (usually \( p \geq .05 \)) does not allow one to reject the null hypothesis. This indicates that the remaining discrepancies between \( \Sigma \) and \( S \) may be explained by sampling fluctuations, and that the model can be considered to fit the actual data sufficiently well.

The \( \chi^2 \) for the primary model was 46.33 (30, \( N = 313 \)), \( p = .03 \), and for the alternative model 62.76 (30, \( N = 313 \)), \( p = .0004 \) (Table 14). Since these values were statistically significant, in theory the discrepancies between the models and actual data could not be attributed to sampling fluctuations alone.

Table 14.

Results of \( \chi^2 \) Test for Primary and Alternative Models, for Total Sample and for Randomly Split Groups A and B

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Primary Model</th>
<th></th>
<th></th>
<th>Alternative Model</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Group A</td>
<td>Group B</td>
<td>All</td>
<td>Group A</td>
<td>Group B</td>
</tr>
<tr>
<td>( n )</td>
<td>313</td>
<td>157</td>
<td>156</td>
<td>313</td>
<td>157</td>
<td>156</td>
</tr>
<tr>
<td>( \chi^2 )</td>
<td>46.33</td>
<td>26.74</td>
<td>29.32</td>
<td>62.76</td>
<td>30.38</td>
<td>42.37</td>
</tr>
<tr>
<td>df</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>( p )</td>
<td>.03</td>
<td>.64</td>
<td>.50</td>
<td>.00</td>
<td>.45</td>
<td>.07</td>
</tr>
</tbody>
</table>

A problem with this interpretation, though, is that the \( \chi^2 \) test for model fit is sensitive to sample size, and with large sample sizes, even trivial deviations between the actual (\( S \)) and model-implied (\( \Sigma \)) covariances may result in a \( \chi^2 \) large enough to have a significant
(p < .05) probability (Hatcher, 1994; Hayduk, 1987; Loehlin, 1992; Tanaka, 1993). The sensitivity of \( \chi^2 \) to sample size has been a common problem among researchers, and several authors (Hatcher; Hayduk; Loehlin) have suggested other approaches to using \( \chi^2 \) as a measure of model fit that avoid this problem. Three alternative methods for using \( \chi^2 \) to assess the fit of the primary and alternative models to the actual data were explored: (1) ratio of \( \chi^2 \) to degrees of freedom, (2) analysis using randomly created subgroups, and (3) comparison with a nested model.

*Ratio of \( \chi^2 \) to degrees of freedom*

In the evaluation of the fit of structural models, some researchers have proposed that the \( \chi^2 \) be used as a 'goodness of fit' measure, using the ratio of \( \chi^2 \) to the degrees of freedom in the model \( \left( \frac{\chi^2}{df} \right) \) as an index of model fit (Bollen, 1989, p. 278; Hatcher, 1994, p. 289). This recommendation is based on the distribution of the \( \chi^2 \) statistic, with the expected value of \( \chi^2 \) equal to the degrees of freedom in the model. An informal criterion for the \( \chi^2/df \) index is that the model may be acceptable if \( \chi^2 \) is less than two times the degrees of freedom. Based on this arbitrary criterion, the primary model demonstrates an acceptable fit \( (\chi^2/df = 1.54) \) while the alternative does not \( (\chi^2/df = 2.09) \). However, the cut-off for this index is arbitrary and could as easily be set at 1.5, in which case neither model would be considered an acceptable 'fit,' or at 2.5, in which case both would be considered an acceptable 'fit.'

*Analysis of models with randomly created sub-groups*

Because the problem with interpreting \( \chi^2 \) is based at least partially on its sensitivity to sample size, the sample size was decreased by randomly splitting the data set into 2 separate sub-groups, A and B. The primary and alternative models were analyzed for both sub-groups. This process is similar to a technique suggested for cross-validation of
models that have been modified when the original model did not fit the data well by randomly splitting the sample into two sub-groups (Bollen 1989, p. 278; Cliff, 1983; Loehlin, 1992, p. 229; Jöreskog, 1993). The results of the $\chi^2$ analyses for sub-groups A and B are also presented in Table 14. In both of the randomly split sub-groups, $\chi^2$ for the primary model was smaller than for the alternative model, as was true in the total sample. While in the total sample, $\chi^2$ for either model did not meet the criteria of close fit of $p \geq 0.05$, $\chi^2$ values for the primary model and the alternative model were not significant in both of the smaller sub-groups ($p \geq 0.05$). Based on the consistently smaller $\chi^2$ for the primary model, it appears to be a more likely theoretical explanation of the underlying relationships among these constructs than the alternative model.

**Development and test of nested model**

Jöreskog (1993) proposed that a set of nested models be developed and used to assess model fit. The first model in the nested set is created by allowing coefficients to vary on the maximum possible number of pathways between constructs. With the flexibility of many possible paths, the model should be able to fit the actual data well, and therefore the discrepancy between $\Sigma$ and $S$ should be small.

Additional models in the nested set impose restrictions on the ways constructs are allowed to relate. Commonly, a path coefficient or correlation coefficient is set to zero, implying no relationship between the constructs. The change in $\chi^2$ ($\Delta \chi^2$) with these additional restrictions is then examined. The critical value for $\Delta \chi^2$ is determined using the difference in the number of degrees of freedom between the two models. If $\Delta \chi^2$ is significant, then the restriction that was imposed can be considered to negatively affect the fit of the model. If $\Delta \chi^2$ is not significant, then the imposition of that restriction can be considered appropriate; that is, the model with the restriction is an equally appropriate explanation of the data to the model without the restriction (Hatcher, 1994, p. 215).
The use of a nested model in the current study offered an additional method for evaluating the fit of the two models of interest. I originally designed the primary and alternate models for this study so that the number of pathways whose coefficients were allowed to vary were equal in both models. Therefore, although it is likely that training in nutrition could affect the time spent teaching both directly and indirectly, through its influence on confidence, only one causal path from training to time teaching was established in each model. To explore the nested model approach, an additional model, the “two-paths model,” was developed that hypothesizes a teacher’s training may affect the time they spend teaching nutrition in two ways: directly and indirectly, by increasing confidence (Figure 12).

A maximum likelihood estimation of the two-paths model was completed, and the standardized path coefficients for this model are shown in Figure 12. The $\chi^2$ for this model and the original two models were compared (Table 15). The difference in $\chi^2$ between the two-paths model and the primary model, which assumes that training only indirectly affects time spent teaching, was not significant ($p \geq .30$). This indicates that these two models fit the data equally well. The difference in $\chi^2$ was significant ($p < .01$) between the two-paths model and the alternate model, which assumes training directly affects time spent teaching but does not indirectly affect it through increasing confidence.
Figure 12. Standardized path coefficients for the two-paths structural model, which assumes a teacher's training may affect the time they spend teaching nutrition in two ways: directly and indirectly, by increasing confidence.

\textbf{Table 15.} Comparison of Fit Indices and Changes in $\chi^2$ for Two-paths Model, Primary Model, and Alternative Model

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$\Delta\chi^2$</th>
<th>$\Delta df$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-paths model (T)</td>
<td>45.52</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary model</td>
<td>46.33</td>
<td>30</td>
<td>0.81</td>
<td>1</td>
<td>$\geq .30$</td>
</tr>
<tr>
<td>Alternative model</td>
<td>62.76</td>
<td>30</td>
<td>17.24</td>
<td>1</td>
<td>$&lt; .01$</td>
</tr>
</tbody>
</table>
Other Indices of Model Fit

While $\chi^2$ is a commonly reported statistic for testing the fit of structural models, a large number of other indices have been developed as well. Hatcher (1994) recommends using Bentler's comparative fit index (CFI) and Bentler and Bonett's non-normed fit index (NNFI) in addition to $\chi^2$ in assessing model fit. For both indices, values over .9 indicate a relatively good fit of the model to the data. A comparison of these indices and the $\chi^2$ assessments of fit is presented in Table 16. Values for both the CFI and the NNFI were greater than .9 for the primary model in the total group and in sub-groups A and B. The CFI and NNFI were less than .9 for the alternative model in the total group and in sub-group B.

Table 16.  
Comparison of Model Fit Indices

<table>
<thead>
<tr>
<th>Fit index</th>
<th>All teachers $(N=313)$</th>
<th>Sub-group A $(n=157)$</th>
<th>Sub-group B $(n=156)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary Model</td>
<td>Alternate Model</td>
<td>Primary Model</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>46.33</td>
<td>62.76</td>
<td>26.74</td>
</tr>
<tr>
<td>$df$</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>$p$</td>
<td>.03</td>
<td>.00</td>
<td>.64</td>
</tr>
<tr>
<td>$\chi^2/df$</td>
<td>1.54</td>
<td>2.09</td>
<td>0.89</td>
</tr>
<tr>
<td>CFI$^a$</td>
<td>.94</td>
<td>.88</td>
<td>1.00</td>
</tr>
<tr>
<td>NNFI$^b$</td>
<td>.91</td>
<td>.81</td>
<td>1.04</td>
</tr>
</tbody>
</table>

$^a$ CFI = Bentler's comparative fit index  
$^b$ NNFI = Bentler and Bonett's non-normed fit index
Summary of Major Results and Conclusions

The major finding from this analysis was that of the two original theoretical models compared, the primary model (Figure 10) was a closer fit to the sample data than was the alternative model (Figure 11). The primary model proposed that in-service teacher training would have only an indirect effect on the time spent teaching nutrition and that this effect would be mediated by the teachers’ confidence in their ability to teach nutrition. The alternative model proposed that both teacher in-service training and teacher confidence would have direct effects on the time spent teaching nutrition. In addition, a third “two-paths” model (Figure 12) was developed that allowed teacher training to exert both an indirect and a direct effect on time spent teaching nutrition. This model provided no improvement in overall model fit in comparison to the primary model. In fact, several of the path coefficients and $R^2$ values for the primary and two-paths models were quite similar, suggesting that including a direct path from training to time spent teaching did not greatly alter the optimal solution. From these results, the conclusion can be drawn that in this population of elementary teachers, in-service teacher training did not exert a direct influence on the time they spent teaching nutrition.

A second finding was that, of the constructs included in this analysis, teacher confidence in their ability to teach nutrition was the strongest predictor of the time they spent teaching nutrition. The path coefficient from teacher confidence to time spent teaching was significant ($p < .01$) in all three of the models tested ($\beta = .34$ in the primary model, .27 in the two-paths model, and .25 in the alternative model). In-service training ($p < .01$) and knowledge ($p < .05$) were both significant predictors of confidence in the primary and two-paths models. From these results a conclusion can be drawn that in this population of elementary teachers, confidence in their ability to teach nutrition appeared to be a key mediator of the relationships between certain aspects of their background (knowledge and in-service training) and their teaching of nutrition.
A third finding was that the relationships between the time spent teaching nutrition and all of the predictor constructs (teacher knowledge, confidence, training, or beliefs) were relatively weak. Only 12% of the variance in the time spent teaching nutrition was explained by the model as a whole. Therefore, an additional conclusion can be drawn that the majority of the variance in the time these elementary teachers spent teaching nutrition was not attributable to their in-service training, confidence, knowledge, and belief about nutrition.

Additional findings from this analysis included the relationships between the other constructs in the models—beliefs about nutrition and nutrition knowledge—and the constructs of in-service training, confidence, and time spent teaching nutrition.

1) The construct “teacher belief that nutrition instruction is important” was not significantly related to the time these teachers spent teaching nutrition ($p > .05$). This result was consistent in all of the models evaluated. The correlations between belief and the other exogenous constructs (training and knowledge) also were not significant ($p > .05$) in any of the models evaluated, with the exception noted above, the correlation between belief and knowledge in the alternative model ($r = .20$, $p < .05$).

2) Teachers’ nutrition knowledge was a significant predictor of their confidence for teaching nutrition ($\gamma = .23$ in the primary model and in the two-paths model, $p < .05$; .41 in the alternative model, $p < .01$). With the exception noted above, the correlations between knowledge and the other exogenous constructs (training and belief) were not significant ($p > .05$) in any of the models evaluated.
CHAPTER 4
DISCUSSION AND IMPLICATIONS FOR FUTURE RESEARCH

What Led to this Study?

The initial impetus for the present study came from my earlier realization that in the nutrition education literature, an implicit assumption was being made that teacher in-service training would have a direct, positive influence on the teaching of nutrition. This assumption was perhaps most concisely stated by Contento et al. (1992): “...teacher preparation is likely to improve teachers’ interest in nutrition, enhance their attitude toward the importance of teaching it, and increase the time they devote to teaching nutrition” (p. 252). The evidence for this conclusion was, at best, mixed, as the same authors noted: “These few nutrition-related studies suggest that teacher preparation neither assures nor is required for effectiveness of school-based nutrition education” (Contento et al., 1992 p. 252). From the literature reviewed for this study, as summarized in Chapter 1, it appeared that some association did exist between teacher training and the teaching of nutrition. However, this relationship had not been assessed in a structural manner.

Another impetus was a common concern in nutrition and health education intervention studies that teachers who had been trained in the use of a new curriculum did not implement it completely (Basch et al., 1985; Bush et al., 1989; Resnicow et al., 1992; Shannon, Bell, et al., 1981; Tinsley et al., 1985). Some authors (Shannon, Bell, et al., 1981) noted that teacher training did not appear to be necessary for effective implementation of a particular curriculum, while others (Basch et al., 1985; Bush et al., 1989; Resnicow et al., 1992; Tinsley et al., 1985) concluded that a lack of impact on students was due to incomplete implementation of a curriculum by teachers who had received training. These studies were also summarized in Chapter 1. Providing in-service
training did not appear to be necessary in some cases, nor sufficient in others, to assure appropriate implementation of nutrition or health curricula.

Finally, since the resources available for advancing nutrition education in schools are scarce (Kalina et al., 1989; Lai et al., 1994), it would seem reasonable to suggest that effective strategies must be found for maximizing the impact of these resources. If in-service training of elementary teachers does not inherently result in an increase in nutrition instruction, then forms of training that are more effective or alternative strategies for improving nutrition education must be found.

This study was conceived as a way to elucidate the relationship between teacher training and the subsequent teaching of nutrition, and to provide information to guide further research on improving nutrition education in elementary schools. The results of this study will contribute to the ongoing discussion of how best to enhance elementary school nutrition education in several ways.

The next section of this chapter deals with the limitations of this research, including limitations due to measurement error and to the type of data and analysis used. Later sections include discussions of the following findings and the implications drawn from these findings:

(1) In-service training in nutrition was not a direct, major influence on the time elementary teachers spent teaching the subject.

(2) Teacher confidence in their ability to teach nutrition was a significant predictor of the time teachers spent teaching the subject.

(3) Teacher beliefs about the importance of nutrition did not affect the time they spent teaching the subject.

(4) Pre-service and in-service training were related in different ways to teacher confidence and the teaching of nutrition.
Limitations of the study

Measurement issues

The data set used in this study was gathered for purposes other than testing these hypotheses. Therefore, some of the constructs were measured using variables that were not optimal for recording responses that would most accurately reflect the true variance of the construct. First, none of the variables were measured in a continuous manner. Discrete, ordinal responses, with two to five possible choices, were used for most variables. In the case of the time spent teaching nutrition, a calculation to estimate the total time spent per year was necessary since the format of the questions did not allow direct use of the responses. However, structural equations methods and the $\chi^2$ test appear to be fairly robust to the use of ordinal variables or variables that are skewed or kurtotic (Hayduk, 1987, p. 328–331).

An additional concern with use of the existing data was the limited number of variables available to measure certain constructs. For example, Paulussen et al. (1994) used a 24-item scale to measure the construct of self-efficacy for implementing an AIDS curriculum. In the current data set, only two items related to confidence for teaching nutrition were available. While these variables adequately represented the construct, they did not allow the variance in measurement of a more detailed scale.

This data set was selected because its advantages—a high response rate and a large, stratified random sample—clearly outweighed these measurement concerns. In both of the above cases, the effect of the limitations imposed by using the existing data set would be to lower the power of the analysis to identify relationships that exist in the population. Since it was possible to test and draw conclusions about the major hypotheses, this limitation does not appear to have adversely affected the research project. Some other relationships that were not statistically significant in this sample might, in fact, be related. Further studies would be necessary to determine if this was indeed true.
Structural models, non-experimental data and causality

The method used in the current study was a structural equations analysis of non-experimental data. Any conclusions drawn from the study must take into account the limitations of this method. Structural models cannot prove causation, but attempt to "determine if the causal inferences of a researcher are consistent with the data" (Bollen, 1989, p. 38, italics in original). If a hypothesized model of relationships among study constructs is determined to "fit" one set of data, the appropriate conclusion to be drawn is that the theoretical assumptions of the model have not been contradicted by the data and may be valid (Bollen, p. 39). In addition, the knowledge that one model provides an acceptable fit with the sample data does not mean that other, untested models would not "fit" the same data better (Loehlin, 1992, p. 228). Therefore, the conclusions drawn from this study have been limited to identifying which of the models that were tested provide the best fit with the data, which findings from this study were consistent or not consistent with findings from other research, and which relationships among the constructs of interest merit further study.

Direction of influence

Bollen (1989) identified isolation, association, and direction of influence as mandatory components of a description of causation. While the design of the current study does not rule out threats to isolation or association, the major concern in relation to the present study is direction of influence.

"...Establishing the direction of influence between two variables is necessary to establishing a causal relation. Knowing that one variable precedes another in time is probably the single most effective means of doing so, but...it is [not] always clear that temporal priority is met" (Bollen, 1989, p. 67).

Data collection for this research consisted of a survey conducted at one point in time. Actions reported by teachers would necessarily precede the point in time when they
completed the survey. Therefore, it can be assumed that the teachers' in-service training and their teaching of nutrition occurred before the survey date. The questions pertaining to in-service training were asked in the past tense (e.g., “In the past five years, how often have you attended training...”). The questions related to their teaching of nutrition were posed in the present tense (e.g., “How often do you teach...”) and would most probably relate to their teaching of nutrition during the school year in which the study was conducted. Since most in-service training opportunities for elementary teachers in Hawaii occur during the summer, it is reasonable to assume that the in-service training teachers reported did precede their reported teaching of nutrition.

The variables measuring the construct of confidence are ambiguous in time. Confidence measures included questions asking (1) if teachers have received appropriate training to teach nutrition and (2) if teachers understand nutrition and can explain it to others. I presume that teachers would respond to these question with their current perceptions. However, from this data set there is no way to tell how long the teachers have held these perceptions. The teacher's current confidence level may be new or it may be long-standing. Therefore, while the training teachers have received and their teaching of nutrition necessarily preceded the time at which they reported their level of confidence, that perception of confidence may or may not have preceded their in-service training, their teaching of nutrition, or both.

This ambiguity is of particular relevance to the relationship between teacher confidence and the time spent teaching nutrition. While the models that were tested assumed that confidence affected the time spent teaching nutrition, it is also reasonable to assume the reverse—that increased time spent teaching nutrition could cause increased confidence for teaching nutrition. In a later section, I will discuss the direction of influence issue in detail.
Does In-service Training Directly Influence the Teaching of Nutrition?

The results of this study suggest that attending in-service training is not a direct, major influence on the amount of time that elementary teachers spend teaching nutrition. In the present study only 12% of the variance in time spent teaching nutrition was attributable to all of the constructs included in the model: teacher training, knowledge, beliefs, and confidence. In the “two-paths” model (Figure 12), which allowed in-service training to have both a direct and an indirect effect on time spent teaching, the direct path from training to time spent teaching was not significant ($\gamma = .11$, NS), while the paths from in-service training to teacher confidence ($\gamma = .42$, $p < .01$) and confidence to time spent teaching ($\beta = .27$, $p < .01$) were significant. This suggests that in-service training has an indirect rather than a direct effect on time spent teaching.

In their survey of elementary teachers, Olson et al. (1986) reported that 26% of the variance in the “extent” of teaching nutrition could be predicted from six factors, one of which was in-service training. In addition, they reported that teachers who had attended in-service training “spent 10% more time teaching nutrition than teachers who did not” (p. 51). Cook et al. (1977), surveying the same population of teachers several years earlier, were able to explain only 3% of the variance in the number of hours of nutrition taught from five variables, which included in-service training as well as having had a high school or college nutrition class. In the Cook et al. survey, teachers who had attended a nutrition workshop reported 2.8 more hours of nutrition instruction per year than other teachers. In these surveys that have sampled from an entire population of teachers, including the present study, in-service training of teachers appears to have an effect, but a small one, on the time spent teaching nutrition. The results of the present

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2 Since some of the independent variables are correlated, it is not possible to attribute a specific amount of variance in the time spent teaching to individual constructs.
study are consistent with an interpretation that this effect is not direct but is mediated by increased confidence.

The modest association between in-service training and time spent teaching may also be an artifact of more interested teachers attending the trainings. Cook et al. (1977) also noted that teachers' interest or attitudes could lead them to both attend in-service trainings and implement nutrition instruction. If this is so, will training less interested teachers be effective in increasing nutrition instruction? Farthing et al.'s (1989) model of support for nutrition instruction (Figure 1) proposed two incentives to motivate teachers to attend in-service training. If, in fact, the relationship that has been identified between training and teaching nutrition is a result of more interested teachers attending the trainings, is it feasible to assume that enticing additional teachers to these trainings will increase their nutrition instruction? Further studies are needed to clarify Farthing et al.'s supposition.

Additional influences on the amount of time elementary teachers devote to teaching nutrition include the teachers' attitudes, perceptions, and other nutrition background, as identified by Cook et al. (1977) and Olson et al. (1986). Also, other researchers have described additional influences on the teaching of health or other subjects or the implementation of new teaching methods (McGraw et al., 1994; Paulussen et al., 1994; Smylie, 1988). These included administrative policies, perceptions, and influences; collegial interactions and perceived norms; student and classroom attributes; and competition from other subjects or curricula. All of these factors would also logically influence the teaching of nutrition.

Given that in-service training explains just a small fraction of the variance in the time elementary teachers spend teaching nutrition, and that many other factors are clearly influential, why do nutrition educators often focus their efforts on providing in-service training? Probably because many of these other factors are recognized as being outside of
the sphere of influence of nutrition educators, or as being difficult to change. For example, the attitudes of school administrators, the grade level taught, and the competition for instructional time from other subjects may not be feasible to modify through nutrition education interventions. Interventions designed to increase the time elementary teachers spend teaching nutrition are likely to target the factors that can be modified through the planned intervention, and one obvious choice is in-service training.

The simplicity of intervening on a single variable is appealing. Teachers who have and have not attended in-service training can be readily identified. However, attempts to simplify an intervention by focusing only on providing in-service training may be doomed to failure. As Perry, Baranowski and Parcel (1990) noted, “Practitioners who are confronted with real problems often like the simplicity provided by a single-variable explanation. They find, however, that many variables must be addressed in a program to produce behavior change” (p. 181).

For the reasons described above, additional predisposing and mediating variables, beyond offering in-service training, need to be included in an intervention in order to effect substantial changes in the amount of nutrition education provided by elementary teachers. In this study I proposed that teacher confidence should be included as one important mediating variable. In the following section I will discuss teacher confidence in detail.

How can In-service Training be more Effective in Improving Nutrition Education?

The results of this study suggest that any influence of in-service training on the amount of nutrition instruction elementary teachers provide is mediated by the teachers’ increased confidence in their ability to teach nutrition. In-service training programs that are designed to increase teacher confidence may, then, have an increased likelihood of influencing the time spent teaching nutrition.
Can in-service training influence teacher confidence?

It appears that in-service training is at least one of the factors which influences teachers' confidence in their ability to teach nutrition. In the present study, 28% of the variance in the teacher's confidence could be attributed to their knowledge of nutrition and their in-service training in nutrition. This is similar to the results of Ross et al. (1991), who found that 31% of the variance in teacher “self-preparedness” to teach the Teenage Health Teaching Modules could be explained by having attended the in-service training and by being a certified health teacher. These results also agree with those of Sheldon and Halverson (1981), who found increased confidence among elementary teachers in their understanding of science concepts and teaching strategies after a series of five 30-minute televised in-service training sessions.

However, these results should not be over-interpreted. Borchers et al. (1992) assessed teacher self-efficacy for using computers in science education before a 2-day workshop, after the workshop, and again after follow-up seminars and implementation assistance. A small but not statistically significant improvement in self-efficacy was found after the workshop, while a much larger and significant ($p < .01$) improvement was found after follow-up seminars and implementation assistance had been provided as the teachers implemented the computer lessons. It is evident from Borchers et al.'s results and from the rather modest amount of variance in confidence explained by in-service training and other variables that all types of in-service training do not inherently engender confidence among teachers.

Over ten years ago, Skinner and Woodburn (1983) suggested that determining methods to increase teachers’ self-confidence as nutrition educators was an area of need for further research, after finding that high school teachers’ confidence was a significant predictor of their effectiveness as nutrition educators. However, in school-based nutrition and health education research, the major focus has been on designing a curriculum to
bring about behavioral change in students, training teachers in its use, and assuming that after training teachers will implement the curriculum as planned. As part of this process, the importance of self-efficacy among students for changing behaviors has been widely noted, but little attention has been paid to the need for teachers to feel confident that they are able to effectively teach nutrition or health concepts. Strategies that may be useful in enhancing teacher confidence include spacing the in-service training sessions (Contento, 1995) and including opportunities for modeling, guided enactment, and feedback (Paulussen et al., 1994).

Barriers to implementation after training

Many nutrition and health education studies have found less than complete implementation of programs after teacher training (Basch et al., 1985; Bush et al., 1989; Parcel et al. 1989; Resnicow et al., 1992; Shannon, Bell et al., 1981; Smith et al., 1993; Tinsley et al., 1985). Perceived barriers to implementation of new curricula after in-service training, such as lack of time or administrative support, have been described (Bush et al., 1989; Contento et al., 1995; Parcel et al., 1989; Weiss & Kien, 1987). In one evaluation of the “Know Your Body” curriculum, Bush et al. (1989) noted the need for additional teacher support from project staff, beyond the amount they had envisioned, and concluded that the process of curriculum implementation by teachers needed to be better understood and improved. Some researchers (Resnicow et al., 1992) have even suggested that because of the low rates of implementation and the perceived barriers, health education specialists might be needed to teach the lessons rather than relying on elementary classroom teachers. Given the resource constraints on public schools, it seems improbable that this solution would be widely implemented. Also, Bonaguro et al. (1988) suggested that health instruction conducted by health educators while the teacher was not present would not be effective in changing student behaviors. Rather than looking to
outsiders to teach a new curriculum, it may be more appropriate to modify training methods to improve a teacher's feeling of confidence and to deal with some of the barriers they perceive.

For example, to overcome the barrier of a lack of time, an in-service training may need to help teachers identify ways to integrate nutrition into academic subjects so that additional instructional time for nutrition is not needed. In planning an in-service training for these integrated lessons, trainers should build-in activities that will develop the teachers' confidence in their ability to integrate lessons across subjects. Assessment of teacher confidence in their ability to successfully integrate nutrition concepts into academic subjects such as mathematics and language arts should also be included (e.g., "I am confident that I can integrate nutrition concepts with mathematics instruction").

**Direction of Influence—Confidence and Teaching of Nutrition**

The purpose of the present study was to investigate confidence as a mediating construct between teacher training and the teaching of nutrition. The theoretical model which included confidence as a mediator of this relationship was a better fit to the data than the alternative model, and of the constructs in the study, confidence was found to be the strongest predictor of time spent teaching nutrition. However, one potential alternative explanation for the relationship observed between confidence and teaching is plausible enough to require comment—that increased confidence for teaching nutrition may be a result of more time spent teaching the subject. As was noted earlier in this chapter, the design of the present research does not allow a definitive conclusion to be made about the temporal precedence of teacher confidence in relation to the teaching of nutrition.

Bandura (1977) described the four major sources of information on which efficacy expectations are based as performance accomplishments, vicarious experience, verbal
persuasion, and physiological states. From this description, a teacher’s self-efficacy for teaching nutrition could be influenced by actually teaching the subject, as it provides information from performance accomplishments. Of course, in-service training could also influence self-efficacy, as it provides information from vicarious experience and verbal persuasion.

The research by Borchers et al. (1992) includes evidence that suggests a path of influence from teaching nutrition to increased confidence. Borchers et al. found a statistically significant increase in teacher confidence during the period of time that teachers were implementing the computer lessons, with follow-up seminars and implementation assistance. Confidence had not increased significantly during the preceding in-service training workshop. Their research design does not allow separation of the impact on confidence of actually teaching the lessons, in comparison to the impact of the additional assistance and follow-up seminars. However, it is conceivable and consistent with Bandura’s (1977) description of self-efficacy that success in teaching the lessons could increase teacher confidence.

While this alternative explanation is plausible, it does not help advance our knowledge about how to make in-service training more effective in influencing teacher behavior. It is more important to examine ongoing assistance to teachers, such as that described by Borchers et al., and its potential effectiveness in increasing teacher confidence. The inclusion of ongoing support for teachers has been proposed by several authors (Paulussen et al., 1994; Contento et al., 1995) as a means to make training more effective. This is clearly a promising area for further investigation.

**Effects of Teacher Beliefs on Nutrition Instruction**

The results of this study did not support the idea that the belief “nutrition is important” was a major determinant of the time teachers spent teaching nutrition. This is
in contrast with other surveys that have found that the perception that nutrition is important (Cook et al., 1977) or an extremely high interest in nutrition (Olson et al., 1986) was a statistically significant predictor of the amount of nutrition taught. As was noted in Chapter 2, in the present study the variance was low in the variables measuring teachers' beliefs. It is possible that in this study the negative skew of the data for these variables and the low variances may have limited the ability to adequately test any impact of teachers' beliefs about the importance of nutrition on teaching. However, other possible explanations for this finding also deserve consideration and will be discussed below.

In the Cook et al. (1977) survey, although the relationship between a belief that nutrition is important and time spent teaching was statistically significant, only 3% of the variance in time teaching could be attributed to all of the variables in the regression equation. The statistical significance found in their study might not signal a relationship of practical importance but might be attributable to their very large sample size.

The Olson et al. (1986) survey reported that an extremely high interest in nutrition had a large impact on the time teachers spent teaching nutrition—an increase of 60% in the time these teachers taught nutrition was attributed to this high interest. The question Olson et al. posed, though, may be measuring a different construct. A teacher's interest in nutrition may have been interpreted by teachers to be their personal interest in teaching nutrition, which would be more likely to lead to increased nutrition instruction than would a general belief that nutrition instruction is important. Teachers may believe that nutrition instruction is important, but still not be personally interested in teaching it.

Methods for measuring attitudes or beliefs about nutrition have varied widely among studies. Cook et al. (1977) and Olson et al. (1986) used single questions to assess the constructs they reported. In the present study, four questions were originally identified to measure the construct "teaching nutrition is important." However, one of those questions
(A6) dealt with the teacher’s personal nutrition behavior and was discarded after it was found to not load highly on the same factor as the other three questions (Table 5 and Figure 7).

O’Connell, Shannon, and Sims (1981) also used multiple questions to assess two attitudes of elementary teachers related to nutrition instruction: “nutrition is important” to measure the importance teachers placed on nutrition in general, and “favors nutrition education in schools” to measure the importance they placed on teaching nutrition in school. Both scales included items similar to those used to measure the construct “teaching nutrition is important” in the present study.

For example, items on the “favors nutrition education in schools” scale included “It’s very important that children be taught nutrition in schools” and “It’s not the job of the schools to teach nutrition.” The “nutrition is important” scale included “I believe that diet is a major controlling factor when it comes to maintaining health and controlling disease” and “A good diet is the most important factor in contributing to good health” (O’Connell et al., 1981). Each scale, however, also included items that could be considered to measure different constructs, such as teachers’ personal concerns about their own nutrition, and their personal desire to teach nutrition. In addition, some of the items they included had high loadings on both of the factors, suggesting that the constructs they were trying to measure were not discrete.

O’Connell et al. (1981) compared mean scores on both scales between groups of teachers who had or had not attended an in-service training, and who had or had not taught nutrition as part of an intervention project. The mean scores of teachers on the “nutrition is important scale” were not significantly different (at $p < .05$ level) between these groups, but those teachers who had taught nutrition had higher mean scores on the “favors nutrition education in schools” scale. Since the “favors nutrition education in schools” scale also included items concerning the teacher’s personal interest in teaching
nutrition, it is possible that the difference between these groups of teachers was due to higher scores on those items. If so, this would agree with the finding of Olson et al. (1986) that there was a relationship between teacher’s interest in teaching nutrition and the amount they taught.

**Effects of Pre-service vs. In-service Training on Confidence and Teaching**

The specific effects of pre-service training on teacher confidence and teaching, in comparison to the effects of in-service training, may merit additional investigation. Pre-service training in nutrition (“Did your degree program include courses in food and nutrition science and/or nutrition education methods?”) was initially included in the present study as part of the measure of total teacher training in nutrition. However, as discussed in Chapter 2, it was removed from further analysis after it was shown that it did not load well on the “training” factor with other measures of teacher training, which all related to in-service training. As shown in Table 5 (Chapter 2), pre-service training exhibited a higher loading on the “confidence” factor ($\beta = .31$) than on the “training” factor ($\beta = .24$). Pre-service training was more closely related to the two measures of teacher confidence than were two measures of in-service training. For these teachers, the correlation coefficient between pre-service training and the belief that their training was appropriate to teach nutrition was $.39$ ($p < .001$), while for in-service training the coefficient was $.25$ ($p < .001$) (Table 17). It also appears that in this sample of elementary teachers, having taken college nutrition courses was related to the teachers’ confidence in their own knowledge ($r = .13, p < .05$). However, no correlation between pre-service training and the time spent teaching nutrition was seen in this study ($r = .09, ns$).
Table 17.

Correlation coefficients between pre-service and in-service training variables and teacher confidence variables (N=313)

<table>
<thead>
<tr>
<th>Variable description and name</th>
<th>Pre-service training (T1)</th>
<th>In-service training (T2)</th>
<th>(T3)</th>
<th>(T4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feels that training was appropriate (C9)</td>
<td>0.39***</td>
<td>0.25***</td>
<td>0.18**</td>
<td>0.18**</td>
</tr>
<tr>
<td>Confidence in knowledge of nutrition (C10)</td>
<td>0.13*</td>
<td>0.07</td>
<td>0.16**</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001

College courses in nutrition or other content areas have not been considered to be appropriate ways to enhance the subsequent teaching of these subjects (Maretzki, 1979). The technical nature of many college science courses has been viewed as irrelevant to the information elementary teachers need to apply in their teaching. For example, Lederman, Gess-Newsome, and Latz (1994) investigated the knowledge structures of pre-service science teachers to assess the development and changes of these structures throughout the participants’ training program. They found that after college course work, knowledge structures related to content knowledge were “fragmented and disjointed with little evidence of coherent themes” (p. 142). The researchers suggested that additional subject matter course work may not be an effective method to improve science teaching. Rather, they felt that different types of training opportunities, including reflection on or use of the subject matter knowledge, would foster development of coherent knowledge structures and therefore improve classroom practice.

The evidence concerning any impact of pre-service nutrition courses on the subsequent teaching of nutrition is quite mixed. Having taken a high school nutrition class and a college nutrition class were both statistically significant influences on time
spent teaching in the Cook et al. (1977) survey, but these relationships may not have been of practical significance because of the low percentage of variance explained in this study, as discussed in an earlier section. Soliah et al. (1983) found that having taken a college or continuing education course in nutrition was a significant predictor of a higher knowledge level \( (p < .001) \) and of a higher score on the “nutrition education practices” scale \( (p < .01) \) among the teachers in their survey. Soliah et al. did not report similar relationships for attendance at in-service nutrition workshops, although this variable was included in their survey. Shannon, Marbach et al. (1981) reported that among the elementary teachers in their intervention study, having taken a prior nutrition course did not correlate with their interest in nor their commitment to teaching nutrition, but noted that only 8 of 125 teachers had taken such a course as a possible explanation for the lack of a relationship. Olson et al. (1986) reported that in their survey 38% of the teachers had taken a college course in foods and nutrition, but this variable was not reported as a significant predictor of the teachers’ “extent” of teaching nutrition.

In the present study, the wording of the question about pre-service training may partially explain the positive results seen among these teachers. In this survey, teachers were asked if their degree program had included “a course in foods and nutrition and/or in nutrition education methods.” This wording may have increased the number of teachers who answered “yes” because a broader range of courses could fit that definition. Some of the respondents may have taken what they considered to be a “nutrition education methods” course. The focus of such a course on how to apply nutrition to a classroom situation could explain the finding of a positive relationship between this variable and the teachers’ confidence for teaching nutrition.

It is, of course, also quite reasonable to assume that teachers with a long-standing interest in nutrition may have enrolled for an elective nutrition course while they were undergraduates, while those with less interest did not. The relationship between having
had pre-service training and confidence in teaching nutrition could be explained by this or by another predisposing variable. However, since the same positive relationship did not exist between pre-service training and nutrition knowledge or time spent teaching nutrition, there appears to be some discrete relationship in this group of teachers between having had pre-service training in nutrition and confidence in their ability to teach nutrition.

Summary and Suggestions for Future Research

In summary, the major findings from this research were that (1) among elementary teachers in Hawai‘i, in-service training in nutrition was not a direct or a major influence on the time they spent teaching the subject, and (2) teacher confidence in their ability to teach nutrition mediated the relationship between in-service training and the teaching of nutrition. These findings are in contrast with implicit assumptions nutrition educators have routinely made when developing nutrition education programs for elementary teachers. Their actions have often implied that the most effective means to enhance nutrition instruction in elementary schools was to provide a summer training workshop for teachers. The findings from this study have provided evidence that this common assumption is probably not correct, and that other approaches to enhancing nutrition education would therefore offer more promise.

Elementary teachers’ confidence in their ability to teach nutrition does appear to be a key mediating construct in the relationship between in-service training and the teaching of nutrition. If in-service training programs are specifically designed to assess and to enhance teachers’ level of confidence in their ability to teach nutrition, the relationship between training and teaching of the subject may be strengthened. Researchers have been frustrated in their attempts to measure the impact of new curricula on student behavior, due to incomplete implementation. Revising the structure of in-service trainings to focus
on teacher confidence may be one key to improving not only teacher implementation, but also student outcomes.

When planning in-service training for teachers, nutrition educators should consider including elements in the training that will increase teacher confidence. Some approaches to training that may increase confidence have been proposed. For example, Contento et al. (1995) suggested the use of spaced training; Paulussen et al. (1994) suggested the use of modeling, guided enactment, and feedback. Researchers could provide evidence of the effectiveness of these approaches by comparing in-service trainings that include them to more traditional in-service approaches.

Nutrition educators need to maximize the impact of the limited resources they have available for nutrition in-service training of teachers. Teacher training programs must be designed to be not only effective but efficient. Methods that do not result in changes in teacher behavior are neither. Resources should be devoted to developing and assessing innovative approaches to teacher training. For example, the use of two-way interactive television and other interactive media could be used to provide programs that include modeling and follow-up and are spaced rather than compressed into a single time block.

As I conducted this study, I identified other unanswered questions or concerns related to improving the effectiveness of nutrition education for teachers. From these questions or concerns I have identified the following suggestions for future research in this area:

- Develop methods to more precisely measure the constructs of (1) teacher confidence for teaching nutrition, (2) teacher belief that nutrition education in the school is important, (3) teacher interest in teaching nutrition, and (4) teacher belief that nutrition is important for health.
- Identify elements in or types of in-service training that may increase teacher confidence in their ability to overcome the barrier of inadequate instructional time.
• Identify the differences in subsequent teaching of nutrition between teachers who have attended in-service training because incentives were offered and teachers who would have attended the training anyway.

• Identify the effects of pre-service training, in comparison to in-service training, on teacher confidence and the teaching of nutrition.

• Identify how and to what extent teacher beliefs about the importance of nutrition affect the amount of time they spend teaching nutrition.
Appendix

SAS Input Statements for Structural Model Analysis

Input for Confirmatory Factor Analysis Model

```
00001 libname net 'C:/sasdata';
00002 run;
00003 proc calis data=net.final;
00004 lineqs
00005   t2 = lmb2 ftrng + e2,
00006   t3 = lmb3 ftrng + e3,
00007   t4 = lmb4 ftrng + e4,
00008   a5 = lmb5 fatt + e5,
00009   a7 = lmb7 fatt + e7,
00010   a8 = lmb8 fatt + e8,
00011   c9 = lmb9 fcon + e9,
00012   c10 = lmb10 fcon + e10,
00013   kscor = .75 fknow + e11,
00014   time = .88 ftime + e12;
00015   std e2 - e5 e7 e8 - e12 = 10*ve;
00016   cov ftrng fatt fknow fcon ftime = 5*1;
00017   var t2-t4 a5-a8 c9 c10 kscor time;
00018   run;
```
Input for Hypothesized Model 1 (Primary Model)

00001 PROC CALIS DATA=net.final;
00002 LINEQS
00003 T2 = LAMB2 FTRNG + E2,
00004 T3 = LAMB3 FTRNG + E3,
00005 T4 = LAMB4 FTRNG + E4,
00006 A5 = LAMB5 FATT + E5,
00007 A7 = LAMB7 FATT + E7,
00008 A8 = LAMB8 FATT + E8,
00009 C9 = LAMB9 FCON + E9,
00010 C10 = LAMB10 FCON + E10,
00011 KSCOR =.75 FKNOW + E11,
00012 TIME = .88 FTIME + E12,
00013 FTIME = BETA1 FCON + GAMMA1 FATT + D1,
00014 FCON = GAMMA2 FTRNG + GAMMA3 FKNOW + D2;
00015 STD E2 - E5 E7 E8 - E12 = 10*VE. ,
00016 D1 D2 = 2*1,
00017 FTRNG FATT FKNOW = 3*1;
00018 COV FTRNG FKNOW = PHI1,
00019 FTRNG FATT = PHI2,
00020 FKNOW FATT = PHI3;
00021 VAR T2-T4 A5-A8 C9 C10 KSCOR TIME;
00022 RUN;
Input for Hypothesized Model 2 (Alternative Model)

00001  PROC CALIS DATA=net.final;
00002  LINEQS
00003    T2 = LAMB2 FTRNG + E2,
00004    T3 = LAMB3 FTRNG + E3,
00005    T4 = LAMB4 FTRNG + E4,
00006    A5 = LAMB5 FATT + E5,
00007    A7 = LAMB7 FATT + E7,
00008    A8 = LAMB8 FATT + E8,
00009    C9 = LAMB9 FCON + E9,
00010    C10 = LAMB10 FCON + E10,
00011    KSCOR = .75 FKNOW + E11,
00012    TIME = .88 FTIME + E12,
00013    FTIME = BETA1 FCON + GAMMA1 FATT + GAMMA2 FTRNG + D1,
00014    FCON = GAMMA3 FKNOW + D2;
00015  STD  E2 - E5 E7 - E12 = 10*VE;,
00016    D1 D2 = 2*1,
00017    FTRNG FATT FKNOW = 3*1;
00018  COV  FTRNG FKNOW = PHI1,
00019    FTRNG FATT = PHI2,
00020    FKNOW FATT = PHI3;
00021  VAR  T2-T4 A5-A8 C9 C10 KSCOR TIME;
00022  RUN;
Input for Hypothesized Model 3 (Two-Paths Model)

00001 PROC CALIS DATA=net.fina1;
00002 LINEQS
00003 T2 = LAMB2 FTRNG + E2,
00004 T3 = LAMB3 FTRNG + E3,
00005 T4 = LAMB4 FTRNG + E4,
00006 A5 = LAMB5 FATT + E5,
00007 A7 = LAMB7 FATT + E7,
00008 A8 = LAMB8 FATT + E8,
00009 C9 = LAMB9 FCON + E9,
00010 C10 = LAMB10 FCON + E10,
00011 KSCOR = .75 FKNOW + E11,
00012 TIME = .88 FTIME + E12,
00013 FTIME = BETA1 FCON + GAMMA1 FATT + GAMMA2 FTRNG + D1,
00014 FCON = GAMMA3 FTRNG + GAMMA4 FKNOW + D2;
00015 STD E2 - E5 E7 E8 - E12 = 10*VE;
00016 D1 -D2 = 2*1,
00017 FTRNG FATT FKNOW = 3*1;
00018 COV
00019 FTRNG FATT = PHI1,
00020 FTRNG FKNOW = PHI2,
00021 FATT FKNOW = PHI2;
00022 VAR T2-T4 A5-A8 C9 C10 KSCOR TIME;
00023 RUN;
REFERENCES


