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ABSTRACT

Six separate studies were conducted using judgments from academic and practitioner experts to determine the knowledge structure of the Certified Financial Planner Professional Education Program (i.e., the organization of discipline topics and the relationships among them). The program consists of six sequential financial planning knowledge domains. The knowledge structure investigations were based on cognitive learning theory; the findings were designed to assist in the development of instructional materials to help learners: (1) solve domain-specific problems; (2) transfer relevant knowledge; and (3) perform successfully on certification examinations that assess complex thinking behaviors. Data were derived from surveys which required participants to rate the degree-of-content relatedness. The six studies organized the initial 175 topics into 50 key areas, based on 15,503 degree-of-content-relationship values provided by 39 experts for 2,511 topic-pair combinations. Principal components analysis techniques transformed relationship judgments into factor loadings. The findings are presented in matrices that can be used to: (1) identify and emphasize key areas in each domain; (2) determine and communicate relationships among topics; (3) specify linkages among topics; and (4) assist in designing a comprehensive review course. Eleven tables present study data, and a 47-item list of references is included. (SLD)

USING COGNITIVE LEARNING THEORY AND DOMAIN KNOWLEDGE STRUCTURE AS GUIDANCE IN PROFESSIONAL EDUCATION COURSE DEVELOPMENT

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ABSTRACT

Six separate studies were conducted using judgments from academic and practitioner experts to determine the structure of the Certified Financial Planner (CFP) Professional Education Program knowledge (i.e., the organization of discipline topics and the relationships that communicate and establish understanding among the topics). The knowledge structure investigations were based on meaningful cognitive learning theory where findings were intended to assist in the development of professional education instructional materials that could help learners (a) solve efficiently domain-specific problems, (b) transfer relevant knowledge to novel situations within a discipline and (c) perform successfully on certification examinations that aim to assess complex thinking behaviors.

Across the CFP I-VI knowledge domains, the resulting six knowledge structures organized an initial 175 discipline topics into 50 key areas overall, based on 15,503 degree-of-content-relationship values provided by 37 experts for 2,511 topic-pair combinations. The data were analyzed for each CFP knowledge domain using the principal components analysis technique where relationship judgments were transformed into factor loadings (i.e., topics judged to be highly-related were grouped together statistically so that a relatively small number of factors could be used to represent interrelationships among domain-specific topics). The factors that emerged for each CFP knowledge domain were interpreted and labeled in reference to the key ideas conveyed by the topics that indicated a common underlying dimension.

For each CFP knowledge domain, findings were presented in a matrix that depicted the organization of key ideas and the topics that formed them. The resulting matrices produced detailed blueprints that could be used to (a) identify and emphasize the key ideas within each CFP domain of knowledge, (b) determine and communicate relationships among topics to help learners make sense of and assign accurate meaning to new information, (c) specify linkages among topics to identify material that could be drawn together throughout instruction to help learners relate new information to prior knowledge in memory and (d) assist in the design of a comprehensive review course.

In summary, the synthesis of both quantitative and qualitative knowledge structure assessment procedures produced a useful strategy that could offer learning-directed and practical guidance for course development efforts related to education in the professions. Specifically, the systematic approach applied in each of the six investigations offered direction in identifying, coordinating and sequencing domain-specific ideas and topics within a profession to produce instructional tasks that could (a) make sense to the learner and (b) be related by the learner to relevant, previously acquired information.

INTRODUCTION

The College for Financial Planning is recognized nationally as the leading provider of distance-based, financial services professional education. The College's Certified Financial Planner (CFP) Professional Education Program, registered with and approved by the International Board of Standards and Practices for Certified Financial Planners (IBCFP), consists of six sequential financial planning knowledge domains: CFP I - Fundamentals of Financial Planning, CFP II - Insurance Planning, CFP III - Investment Planning, CFP IV - Income Tax Planning, CFP V - Retirement Planning and Employee Benefits and CFP VI - Estate Planning.

For the past 18 years, the College's home-study materials have been designed to help adult learners attain educational goals through the use of domain-referenced, measurable objectives (e.g., see models developed by Bloom, Englehart, Furst, Hill & Krathwohl, 1956; Mager, 1962; Popham, 1981). Course goals and objectives have been determined by advisory panels of experts and job analysis studies that have identified the professional requirements needed for competent performance of financial planning services.

THEORETICAL FRAMEWORK

In keeping informed of cognitive-based conceptions about human learning (i.e., the science of understanding the mental activities that occur throughout the learning process), the College for

Financial Planning has continued to investigate ways to design instructional materials that will lead novices efficiently and effectively toward financial planning expertise. Given contemporary educational psychology views in which learning is believed to be an active, constructive and goal-oriented process dependent upon the mental activities of the learner (Anderson, 1985; Ausubel, Novak & Hanesian, 1978; Masters & Mislevy, 1990; Shuell, 1986; Van Rossum & Schenk, 1984; West & Pines, 1985), the College's course development efforts have addressed the promotion of meaningful knowledge acquisition. Based on principles within the meaningful cognitive learning paradigm (see Shuell, 1990), the structure of financial planning knowledge domains is viewed as critical in guiding efforts to develop instructional materials that will foster meaningful learning.

OBJECTIVES

Six separate studies were conducted to identify and interpret the structure of knowledge for each component (i.e., knowledge domain) of the College's CFP Professional Educational Program. The two primary objectives of each study were to determine both the organization of and the types of relationships among key topics for the six CFP knowledge domains. Both types of information were deemed essential in providing guidance for the design of CFP instructional materials that would encourage learners to (a) solve efficiently financial planning problems, (b) transfer relevant knowledge to novel financial planning situations and (c) perform successfully on measures that aim to assess higher-order thinking behavior.

METHODOLOGY

The IBCFP recently endorsed a total of 175 key topics to represent collectively the CFP I-VI knowledge domains, based on six separate topic specification workshops conducted in collaboration with the College for Financial Planning during 1989 (see IBCFP, 1990; Skurnik, 1990). Using the IBCFP key topics for each CFP knowledge domain, both quantitative (Diekhoff & Diekhoff, 1982) and qualitative (Donald, 1983) structural knowledge assessment procedures were synthesized to produce a practical technique for (a) inferring the organization of professional education knowledge domains and (b) communicating topic interrelationships to promote meaningful cognitive learning.

A pilot study of the technique and the data collection instruments was conducted during May, 1990, with 16 Academics from the College's Education Division. The preliminary research (a) verified the utility of the technique, (b) enabled considerations about statistical assumptions to be examined regarding the instrumentation and the treatment of the data and (c) provided insight for the six separate studies that followed (see McCallin & Gibley, 1990).

Sample

The samples used in each of the six investigations were comprised of nationally-recognized experts, including the College's content-specialist course developers (total n=39, average sample size per CFP knowledge domain = 6). The nonrandom samples were chosen deliberately to ensure that the detailed data required to ascertain expert-based knowledge structures were collected from only those individuals who (a) represented proportionately both academic and practitioner financial planning subgroups and (b) also were qualified and willing to provide the in-depth input needed. Additional justification for the sample sizes and sampling considerations used within the present studies was based on prior research which found that experts generally provided similar and very consistent judgments about subject-matter relationships within their domain of expertise (Chi, Feltovich & Glaser, 1981; Chase & Simon, 1973; Larkin, McDermott, Simon & Simon, 1980; McKeithen, Reitman, Rueter & Hirtle, 1981; Shavelson, 1974).

Research Design

The descriptive research design was utilized in the six knowledge structure studies because the overall goal was aimed at describing both the organization of the IBCFP topics and the types of relationships among the topics within each CFP knowledge domain. The data were collected using a survey approach to obtain experts' time-bound associations (i.e., judgments indicating degree-of-content-relationship) between all possible randomly-ordered, topic-pair combinations within each CFP knowledge domain. The investigations were planned to provide a descriptive account of each CFP knowledge domain that could be used to assist in the design of instructional materials that would foster meaningful learning.

Quantitative Measures

The quantitative data collection instruments were developed to obtain values indicating the degree-of-content-relatedness between topics for all topic-pair combinations by CFP knowledge domain.

The measurement approach was based on a numerical relationship judgment technique devised to help instructors organize and communicate structural knowledge within a course or discipline area (see Diekhoff & Diekhoff, 1982). While a number of methods for assessing structural knowledge have been proposed over the past two decades (e.g., compare-and-contrast essay tests, concept similarity judgments, card sorting, cued and free recall tasks, word associations, graph construction and concept mapping techniques) (Biglan, 1973; Champagne, Klopfer, DeSena, & Squires, 1981; Fenker, 1975; Gorodetsky & Hoz, 1980; Johnson, 1967; Naveh-Benjamin, McKeachie, Lin, & Tucker, 1986; Novak, Gowin, & Johansen, 1983; Preece, 1976; Shavelson, 1974; West & Pines, 1985), the approaches generally have been very subjective and time intensive to construct and score.

The numerical relationship judgment technique proposed by Diekhoff & Diekhoff offered an alternative to the time-consuming and oftentimes cumbersome procedures associated with (a) multidimensional scaling analysis of concept similarity judgments, card sorting and free recall tasks, (b) hierarchical cluster analysis of word associations, card sorting and graph construction tasks, (c) lattice-based ordered tree analysis on cued and free recall strings and (d) content analyses on tree construction and concept mapping outcomes. In addition to these considerations, research using simple and multiple correlations between test scores (i.e., a multiple-choice test over knowledge of domain topics, an essay test covering relationships among domain topics, and a relationship judgments test that required rating the strength of content relationship between topics presented in pairs) provided evidence to support the use of numerical relationship judgments as a valid means of assessing domain knowledge structure (see Diekhoff, 1983).

Although numerical relationship judgment measures are not without shortcomings (e.g., if psychological processes produce asymmetrical distances, it may be difficult to interpret the data; usually there are no provisions for obtaining qualitative information about propositional meanings), considerable efforts over the past two decades to assess the knowledge structure construct indicate that no single technique can be used to provide inclusive information. It is for this reason that both quantitative and qualitative approaches have been pursued to assess multiple aspects of CFP domain knowledge structure.

The quantitative measures used in the present investigations were designed with reference to psychometric considerations not addressed in earlier studies (e.g., Biglan, 1973: Diekhoff 1983; Diekhoff & Diekhoff, 1982; Wainer & Kaye, 1973). In addition to a provision for obtaining qualitative information about topic relationships, attempts were made to control for nonrandom judgment error, a reduction in the richness of the raw data and violations to assumptions about both the distributions and the properties of the data as well as the subject pools. Specifically, the successive-interval continuum on which topic-pair-relatedness values were based involved the assumptions that (a) data were dispersed across all units along the defined continuum (b) participants were capable of assigning values that corresponded to the degree to which stimuli were related within their domain-specific cognitive structures and (c) experts within each study were similar with respect to domain knowledge, so that topic-pair values differed primarily because of unrelated random errors in judgment.

The measurement operation required individuals within each sample to judge independently CFP topic-pair stimuli along a defined, degree-of-content-relationship continuum that contained successive, equidistant units labeled from one to nine. The scale was anchored so that a value of "1" indicated that topic-pair members were not related beyond a superficial domain association whereas a value of "9" conveyed a very strong degree-of-content relationship between two topics. The middle interval along the continuum (i.e., a value of "5") designated a moderate degree-of-content relationship. In essence, the continuum represented a hypothetical range of values from one to nine that could be used to express relatedness between two topics within a professional education knowledge domain.

The unique approach used to index topic relatedness was undertaken with the recognition that (a) ordering was the appropriate mathematical property applicable to the obtained values, (b) the use of the numeric values that approached interval-level measurement did not imply the property of uniform distance between values and (c) the scale limits truncated continuum values (i.e., since all topics within each CFP part were related by virtue of domain membership, yet none were identical to one another, values below one or beyond nine would not have been meaningful). Efforts to attain equality of psychological intervals among continuum units included the attachment of relatedness values to all intervals. No assumptions were made, however, regarding the psychological equality of the nine successive units. It was assumed only that the ordered continuum defined the set of possible values that could be assigned during the measurement process and that unit boundary lines were stable except for sampling errors. In addition, a measurement-independent position was taken (Burke, 1963) in that once the measurements were obtained, they were viewed as numbers (regardless of the original scale) that could be subjected to computations and statistical analyses as long as the data met assumptions required by the methods used (see Gardner, 1975; Ware & Benson, 1975).

Efforts to reduce sampling error associated with the pairing and proximity error associated with the presentation of topic-pair stimuli were undertaken utilizing a custom-designed computer algorithm (Raju, 1990). The program generated all possible random combinations of topic-pair stimuli for each CFP knowledge domain. Next, the nine-unit, degree-of-content-relationship continuum was included at the top of every page containing topic-pair stimuli. In this manner, the resulting measurement instrument for each CFP knowledge domain contained all possible pairs of key topics in a random-order, successive-intervals format that was the same for all subjects within each study.

By using the defined continuum to obtain numerical values that conveyed structural knowledge information (i.e., content-relatedness judgments were used to explore the interrelationships among topics within each CFP knowledge domain), it was possible to (a) determine the distribution of the data for each CFP domain of knowledge, (b) identify nonrandom judgment errors and (c) reduce random judgment error by averaging topic-pair values across subjects.

In summarizing, there were three important distinctions that needed to be addressed prior to concluding discussion about the development and the utilization of the data collection instruments.

First, the criterion upon which topic-pair stimuli were judged was specified as "CFP domain relatedness" (i.e., the degree or magnitude to which topics were connected or associated). The criterion was viewed as distinct from judgments based on "similarity" or "difference" reference frames where topics would have been be compared and rated in terms of how identical or how different they were from each other.

Next, the current studies were aimed at determining the degree-of-content-relatedness between topics presented in pairs, not whether one topic within a pair was of greater or lesser quantity than the other in some defined respect. If the latter had been the research focus, then the traditional pair comparisons method would have been used to obtain and scale the data (i.e., a discriminant model could have been applied to scale ordinal estimates about whether one topic within a pair was greater or lesser than the other topic with respect to an attribute) (see Thurstone, 1927). Given the present research foci, the successive-interval, numbered continuum used to judge the content relatedness of topic-pair stimuli served as a valid means through which data relevant to the purposes of each investigation could be acquired.

Fi y, the measures were developed to obtain experts' judgments in reference to a single, specified attribute (called CFP domain relatedness), based on the overall goals to organize and integrate domain knowledge in ways optimal for meaningful learn g. While multidimensional scaling analysis could have been used to determine (a) unknown dimensions involved in the judging of topic-pair stimuli or (b) how experts may have used certain dimensions when determining topic-pair relatedness, the primary objectives of the current investigations would not have been addressed.

Procedure

For each of the six studies, experts were contacted by telephone to request their participation in an on-site, one-day advisory committee session and to confirm their willingness to serve as topic-pair judges prior to the meeting. Following the precontact activity, participants in each group received the numerical relationship measure containing all possible pairwise combinations of topics for their CFP domain of expertise, accompanied by (a) a cover letter that outlined the responsibilities of respondents, (b) a summary of the research project, (c) the IBCFP Topic/Subtopic list for the relevant CFP knowledge domain and (d) a one-page set of directions that specified how stimuli were to be judged. The topic-pair measure for each CFP knowledge domain was separated into manageable parts so that experts could judge each section in about one-hour intervals. All participants were contacted approximately two days after they received the materials to ensure that everyone understood what was required of them and to emphasize the deadline for receipt of the data. Data were needed prior to the advisory committee meetings so that nonrandom judgments errors could be reconciled during each on-site session.

In all six investigations, respondents were asked to judge independently and individually each pair along the nine-point continuum in terms of the degree-of-content-relationship they perceived to exist between the topics. A value of "1" was to indicate that topics were not related beyond a superficial domain association, whereas a value of "9" was to convey a very strong content relationship between topics. Experts also were requested to (a) refer frequently to their IBCFP Topic/Subtopic list throughout the judgment activity to keep in mind a common context and to maintain among participants a consistent interpretation of topic labels, (b) consider carefully and repeatedly the utilization of all nine units along the continuum when judging stimuli and (c) judge the separate topic-pair sections at different times to control for rater fatigue.

Treatment of the Quantitative Data

Ninety-five percent of the total number of participants across the six investigations returned completed topic-pair surveys by the specified deadlines. A summary of the data received is provided in Table 1.

Table 1. Topic-Pair Data by CFP Knowledge Domain

CFP Domain	# of Key IBCFP Topics	# of All Pairwise Topic Combinations	Original # of Experts Surveyed	Resulting # & (%) of Those Who Responded	Total # of Topic-Pair Values*
I	21	210	6	6 (100%)	1,260
II	31	465	6	5 (83%)	2,325
III	33	528	7	6 (86%)	3,168
IV	32	496	7	7 (100%)	3,472
V	29	406	6	6 (100%)	2,436
VI	29	406	7	7 (100%)	2,842
TOTAL	175	2,511	39	37 (95%)	15,503

*Less than one-tenth of one percent of returned surveys contained missing values. In such instances, missing data were replaced with the average value for the observation.

Examination of Assumptions

Descriptive analyses were performed on the topic-pair data for each CFP knowledge domain. The data distributions were examined with reference to the assumptions that (a) the ordered continuum defined the set of possible values that could be assigned during the measurement process and (b) the topic-pair-relatedness judgments would be dispersed across all units along the defined continuum.

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Histograms of the frequencies of topic-pair values and summary statistics were produced by CFP knowledge domain to display and describe the shape of data distributions, the variability among relatedness judgments and where typical values were concentrated. The summary statistics appropriate for ordinal-level measurement indicated that the distribution of data for each investigation satisfied both assumptions as topic-pair-relatedness judgments were spread across all possible values along the continuum (Table 2).

Table 2. Summary Statistics for CFP I-VI Data Distributions

CFP Domain	Median Value	Range	Skewness	Kurtosis
I	4.000	8.000	.255	-1.237
II	3.000	8.000	.575	-1.039
III	5.000	8.000	.062	-1.285
IV	2.000	8.000	.893	-.735
V	5.000	8.000	.107	-1.561
VI	5.000	8.000	-.113	-1.207
Median	4.500	8.000	.181	-1.222

While none of the six distributions was precisely symmetrical (a condition seldom met and not mandated for the analyses performed on the CFP knowledge structure data), it was clear that raters in each study took seriously the tasks to consider all intervals along the continuum and to use their discriminative powers to judge independently the content relatedness of topic-pair stimuli (Table 3).

Table 3. Percent of Data Appearing within Each Unit Along the Relatedness Continuum by CFP Knowledge Domain

Continuum Intervals

CFP Domain	One (%)	Two (%)	Three (%)	Four (%)	Five (%)	Six (%)	Seven (%)	Eight (%)	Nine (%)	TOTAL (%)
I	20.0	14.6	9.3	9.3	10.5	10.2	10.8	6.9	8.5	100.0
II	27.3	17.4	10.1	8.9	7.6	6.6	8.1	7.6	6.4	100.0
III	11.8	15.3	11.9	8.7	12.4	9.4	14.3	11.8	4.3	100.0
IV	47.5	10.4	7.8	4.3	5.1	4.4	7.5	5.8	7.2	100.0
V	28.4	7.5	7.8	5.3	8.1	5.7	11.0	7.7	18.7	100.0
VI	7.7	12.5	11.5	7.3	13.4	10.7	15.5	11.7	9.7	100.0
Overall	24.6	12.7	9.8	7.0	9.4	7.6	11.3	8.7	8.9	100.0

Other evidence about the quality of topic-pair-relatedness judgments was reviewed through efforts to identify nonrandom judgment errors. The standard deviation of the mean value for each topic pair was inspected to gauge the variability of relatedness judgments. It was hypothesized, on an a priori basis, that highly variable topic-pair values generally would indicate either varying interpretations of topic labels (i.e., the primary reason for nonrandom judgment errors) or differences in opinions about the content relatedness of some topics. Given the small sample sizes, the large number of topic pairs within each study and past research which indicated that even experts varied in some judgments across all topic pairs (Diekhoff, 1983; Fenker, 1975), it was decided that stimuli which had standard deviations in relatedness judgments approaching or exceeding 3.0 would be reexamined during the on-site advisory meetings. The standard deviation criterion value was established by (a) examining the range and distribution of variabilities obtained overall (i.e., 0.00 to 4.12), (b) considering assumptions about the nine-point continuum and (c) evaluating the index of dispersion at which relatedness judgments could be considered unequivocally as "highly variable". Across all CFP knowledge domains, 3% to 16% of the original judgments required reexamination.

The reassessment activity was conducted at the beginning of each advisory session. Since the intent was to reconcile only nonrandom judgment errors attributable to varying interpretations of topic labels (i.e., no attempts were made to reconcile idiosyncratic opinions about certain topics), experts revisited and discussed the relevant IBCFP Topic/Subtopic descriptions. Following the activity to eliminate possible ambiguity of topic labels, participants rejudged independently topic pairs, presented in a descending order from most to least variable, according to the same procedure used to obtain the initial relatedness judgments. Subjects were not knowledgable about (a) the manner in which stimuli to be rejudged were presented or (b) the original values of the topic pairs. In each study, however, experts noticed that certain topics appeared frequently in the pairs that needed to be reexamined. This was found to be the case especially among the topics within stimuli that received relatively more-dispersed original content-relatedness values and hence, were listed at the beginning of the rerating instrument. This observation supported further the notion that varying interpretations of topic labels contributed significantly to nonrandom judgment errors.

Results from the reassessment exercise showed a marked improvement by reducing the proportion of topic-pair-relatedness values that were highly variable (Table 4). Even so, it was recognized and expected that experts would vary to some degree in their judgments due to both random judgment error and differing opinions about some topics (Biglan, 1973; Chi, et al., 1981; Diekhoff, 1983; Fenker, 1975; Schoenfeld & Herrmann, 1982; West & Pines, 1985).

Table 4. Status of Highly-Variable Topic-Pair Relatedness Judgments Before and After Rerating Exercise

		Status			
CFP Domain	Proportion of Highly-Variable **Original Judgments** (%)	Proportion of Rerated Pairs that Decreased in Variability (%)	Proportion of Rerated Pairs that Remained Unchanged in Variability (%)	Proportion of Rerated Pairs that Increased in Variability (%)	Proportion of Highly-Variable **Final Judgments** (%)
I	13.33	71.43	17.86	10.71	2.86
II	6.67	65.53	32.24	3.23	0.86
III	3.03	25.00	68.75	6.25	0.57
IV	10.89	51.86	44.44	3.70	1.61
V	15.52	49.21	25.40	25.39	7.88
VI	4.93	45.00	50.00	5.00	0.49
Median	8.78	50.54	38.34	5.63	1.24

Following the rerating activity to minimize nonrandom judgment error, the objectivity of experts' judgments was examined with respect to the assumptions that (a) participants were capable of assigning values that corresponded to the degree to which stimuli were related within their domain-specific cognitive structures and

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(b) respondents within each CFP study were similar with respect to domain knowledge so that relatedness values differed primarily because of unrelated, random judgment errors.

It was hypothesized that if experts were similar in domain knowledge and capable also of assigning values that represented the structure of that knowledge, then their topic-pair-relatedness judgments would be related linearly and highly. In essence, the internal consistency among experts was viewed as an index of both judgment reliability and construct validity.

The interdependent assumptions were tested by computing (a) inter-rater correlation coefficients, (b) summary and rater-total statistics and (c) Cronbach's Alpha reliability coefficients to examine the extent of agreement among experts within each investigation. As summarized in Table 5, experts were found to be very consistent in their relatedness judgments.

Table 5. Reliability of CFP I-VI Topic-Pair Relatedness Judgments

CFP Domain

	I (n=6)	II (n=5)	III (n=6)	IV (n=7)	V (n=6)	VI (n=7)	Overall (Median)
Team Reliability (Alpha)	.84	.88	.85	.90	.90	.83	.87
Average Inter-Rater Correlation	.47	.60	.50	.58	.62	.41	.54

The high internal consistency coefficients also provided evidence about validity of the obtained measurements where the intent was that experts judged stimuli according to one dimension of psychological variation (i.e., CFP domain relatedness). Thus, even though the stimuli judged could have been multidimensional, the high internal consistency indices supported the assumption that experts generally were successful in judging topic pairs according to the unidimensional, degree-of-content-relationship continuum.

The information, combined with the observation that respondents within each study had fairly comparable variances (i.e., alphas and standardized item alphas virtually were identical), furnished proof that the values obtained generally were (a) associated linearly and (b) unidimensional with reference to the relatedness continuum.

In summary, it was determined that assumptions about the data distributions as well as the subject pools were met in all six investigations. Efforts to minimize nonrandom judgment errors also were found to be successful. The status of the data was regarded as ordinal measurement and only approached that of an interval scale. Like any successive-interval data, methods of correction and scaling could have been used to transform values (more or less successfully) into interval measurements (Guilford, 1954). However, such procedures were not deemed necessary because data were subjected only to statistical methods where (a) the distributional assumptions justified the analyses and (b) it could be demonstrated that usefulness of the values was enhanced by the treatment (Crocker & Algina, 1986).

Scoring and Analyses

The raw data representing the content relatedness of topic-pair stimuli still contained a random error component that could be minimized further. Across all studies, medians were computed from the original 15,503 topic-pair-relatedness judgments to produce 2,511 single values. The median was chosen as the measure of central tendency with reference to the ordinal mathematical property of values along the numerical relationship continuum and to minimize the influence of the few highly-variable, outlying values that remained after the rerating activity.

Based on the Diekhoffs' structural knowledge assessment method, the median of the numerical ratings for each topic pair by CFP knowledge domain was transformed into a decimal notation to serve as an index of correspondence (i.e., a median relatedness value of 1 became .1, a 2 became .2, etc.). In essence, the median topic-pair-relatedness values were viewed as quasi-correlations that could be used to identify structural interrelationships.

The pragmatism of the technique was appealing yet also approached with caution in that it was imperative to recognize limitations of treating median topic-pair-relatedness values as if they were correlations. The approach published by the Diekhoffs' failed to address assumptions about linear association, the distributions and properties of the data, the subject pools and the measurement instruments. While all of these concerns have been addressed already, the following section supplemented further information about issues that were acknowledged prior to treating the decimal form of the median topic-pair-relatedness values as "correlations".

The continuum values used to index the magnitude of content relatedness between topics were viewed as numerical indices of "going togetherness" not unlike measures of relationship communicated through correlation coefficients. Such an approach has not been unusual in research about the knowledge structure construct as other quasi-correlation coefficients also have emerged over the past 20 years to communicate aspects of relatedness between topics in terms of the distance between their semantic profiles (i.e., psychological representations in long-term memory).

For word association data, analyses usually have involved the computation of a coefficient where the relatedness between words was expressed according to the degree of overlap of their property lists (see Garskof & Houston, 1963; Johnson, 1967; Johnson, 1967; Shavelson, 1974). The relatedness coefficients have been entered into a symmetric matrix and analyzed using factor analysis, multidimensional scaling or hierarchical cluster analysis techniques to examine the structure underlying the observed coefficients. In graph construction approaches, the distance between any pair of words has been calculated by adding the numbers associated with the line or lines connecting the pair of words (see Rapoport, 1967; Rapoport & Fillenbaum, 1972; Shavelson, 1974). The distances between all pairs of words on the graph(s) have been represented in either separate symmetric proximity matrices for individuals or in a mean or median matrix for a group. Cluster analysis or multidimensional scaling techniques have been applied to uncover the dimensions underlying the proximity data. Other techniques have been based on a clustering algorithm (Reitman & Rueter, 1980) where sets of cued and noncued recall strings have been transformed into ordered trees. The relatedness of two or more trees has been assessed using a nonmetric measure of resemblence (see Hirtle, 1982; McKeithen et al., 1981; Naveh-Benjamin et al., 1986).

In summary, nonmetric, quasi-correlational indices have been used for a number of years to represent aspects of knowledge structures. The data have been analyzed using various statistical techniques (i.e., primarily factor analysis, multidimensional scaling or hierarchical cluster analysis) where each method has involved different assumptions about the nature of the observed data and the structure or dimensions underlying them.

Overall, it was concluded that there was sufficient justification for treating the median topic-pair relatedness values as quasi-correlational indices that were (a) not obtained by chance alone, (b) indicative of the extent to which discipline topics were associated with respect to the unidimensional attribute "CFP domain relatedness" and (c) meaningful in so far as values were within the degree-of-content-relationship continuum intervals of one through nine (i.e, all topics by CFP study were related at least superficially by virtue of domain membership, yet none of the topics had identical, completely overlapping property lists).

The topic-pair median indices for each CFP knowledge domain were entered into separate symmetrical matrices and treated as though they were correlations. Principal components analysis was used to group highly-related topics together so that a relatively small number of "key idea areas" could be used to represent the underlying structure of each CFP knowledge domain (Harman, 1967). The appropriateness of utilizing the factor analytic model was evaluated using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy index to compare the magnitudes of the obtained topic-pair-relatedness indices to the magnitudes of the partial topic-pair-relatedness indices (i.e., the quasi-correlations between pairs of topics were examined to determine the degree to which they could be explained by the other domain-specific topics). As shown in Table 6, the KMO statistic for each CFP knowledge domain was high enough to justify use of the factor analytic model (Norusis, 1988).

Table 6. Kaiser-Meyer-Olkin Measure of Sampling Adequacy by CFP Knowledge Domain

CFP Domain	KMO Index
I	.770
II	.787
III	.803
IV	.805
V	.930
VI	.852
Median	.804

Using SPSS/PC+ microcomputer data management and analysis software, the principal components analysis technique was applied to each of the six matrices to obtain uncorrelated linear combinations for factor extraction (Hotelling 1933). The principal components technique was utilized because it provided an appropriate solution for condensing statistically the topic-pair-relatedness data into a limited number of linearly-independent factors to discover the underlying order of each CFP knowledge domain (see Thurstone, 1947).

Three sources of information were examined to determine the number of factors needed to represent parsimoniously the relationships among sets of the many interrelated topics within each study. First, the total variance explained by each factor was examined, accompanied by both the percentage and the cumulative percentage of variance attributable to respective factors. Next, the factors that accounted for variances greater than one also were reviewed (i.e., factors with eigenvalues below one generally were no more efficient than a single topic was in representing the data). Finally, scree plots of the eigenvalues associated with each factor were evaluated in light of the preceding information. The combined sources indicated the utilization of models ranging from six to eleven factors (Table 7).

Table 7. Summary of Factor Extraction Data by CFP Knowledge Domain

Factor Statistics

Factor Extracted	CFP I Eigen-value	CFP I Variance Explained (%)	CFP II Eigen-value	CFP II Variance Explained (%)	CFP III Eigen-value	CFP III Variance Explained (%)	CFP IV Eigen-value	CFP IV Variance Explained (%)	CFP V Eigen-value	CFP V Variance Explained (%)	CFP VI Eigen-value	CFP VI Variance Explained (%)
1	9.65	(45.9)	12.48	(40.3)	16.45	(49.8)	10.86	(33.9)	14.65	(50.5)	15.69	(54.1)
2	2.63	(12.5)	4.98	(16.1)	2.95	(8.9)	3.38	(10.6)	4.26	(14.7)	2.94	(10.2)
3	2.21	(10.5)	3.66	(11.8)	2.23	(6.8)	2.40	(7.5)	3.19	(11.0)	2.43	(8.4)
4	1.40	(6.7)	2.19	(7.0)	2.06	(6.2)	1.97	(6.2)	1.74	(6.0)	1.65	(5.7)
5	1.31	(6.2)	1.57	(5.1)	1.91	(5.8)	1.82	(5.7)	1.55	(5.4)	1.41	(4.9)
6	1.18	(5.6)	1.45	(4.7)	1.61	(4.9)	1.70	(5.3)	1.43	(4.9)	1.37	(4.7)
7			1.29	(4.2)	1.44	(4.4)	1.46	(4.6)	1.13	(3.9)	1.27	(4.4)
8			1.01	(3.2)	1.31	(4.0)	1.36	(4.3)			1.05	(3.6)
9					1.14	(3.5)	1.23	(3.8)				
10					1.13	(3.4)	1.15	(3.6)				
11							1.06	(3.3)				
Cumulative Variance Explained	87.6%		92.3%		97.7%		88.7%		96.4%		95.9%	

Following the factor extraction phase, varimax rotation was used to transform each of the six matrices to simple structure for interpretation. Allowing for correlations among factors (i.e., achieving simple structure through oblique rotation) did not vary significantly from or clarify further any of the six matrices that emerged from the orthogonal rotations. Thus, only findings obtained from the varimax method were presented. In addition, plots of factor loadings and factor score estimations were deemed tangential to the research objectives; therefore, neither were reported.

Qualitative Assessment

The content of the factors which emerged from the content-relatedness data were reviewed by the College's subject-matter experts within each CFP knowledge domain. The experts interpreted and named the key idea conveyed by the topics which loaded significantly (i.e., .40 or greater) on each factor. Considerations involved in the interpretation and naming of factors' key ideas included (a) the sophistication of and expectations about learners' domain-relevant prior knowledge, (b) how factor labels typically should be understood by learners and (c) how factor labels communicated essential aspects of a CFP knowledge domain.

Next, the same individuals were asked to utilize six types-of-topic-relationship categories (Donald, 1983) to identify the kinds of connections and processes required to (a) comprehend the underlying key ideas and (b) determine the ways in which such ideas fit into the overall context of a particular CFP knowledge domain. The qualitative categories, accompanied by brief descriptions, have been listed in Table 8.

Table 8. Types of Topic Relationships Categories (Donald, 1983)

Relationship Category	Description
Associative	Topics define, describe or identify each other.
Functional	Topics have a similar outcome or purpose.
Structural	Some of the topics are classes or subsets of the other topics.
Procedural	Topics are or can be ordered to express a known sequence or operation.
Logical	Topics have a logical or conditional order.
Causal	Topics have an explicit cause-effect relationship.

Finally, the general lessons or study assignments within each CFP knowledge domain (i.e., course syllabi were designed with reference to advisory committee input and outcomes from the knowledge structure research) were linked to the topics they addressed within each factor. Academics utilized the combined sources of information to assist them in their CFP professional education course development efforts.

RESULTS

The resulting number of factors by CFP knowledge domain and the corresponding percentage of total variance explained (i.e., the extent to which factor loadings accounted for relationships among topics within each CFP knowledge domain) have been summarized in Table 9.

Table 9. **Number of Factors (Key Ideas) and Percentage of Total Variance Accounted for by CFP Knowledge Domain**

CFP Domain	Resulting Number of Factors	Percentage of Total Variance Explained (%)
I	6	(87.6)
II	8	(92.3)
III	10	(97.7)
IV	11	(88.7)
V	7	(96.4)
VI	8	(95.9)
Median	8	(94.1)

The factor labels assigned by the College's subject-matter experts for each CFP knowledge domain are given in Table 10.

Table 10. Factor Labels Representing Key Ideas within Each CFP Knowledge Domain

Factor #	CFP Domain I	II	III	IV	V	VI
1	Financial Planning Functions	Life Insurance	Theoretical Portfolio Construction & Management	Property Dispositions	Types of Qualified Retirement Plans & Considerations	Gift Tax
2	Economic Concepts	Medical Insurance	Fixed Income Securities	Direct Participation Programs	Personal Contributory Retirement Plans	Gross Estate Inclusion
3	Ethical, Regulatory & Legal Issues	Property & Liability Insurance	Real Estate & Tangible Assets	Compensation Issues & Employee Benefits	Types of Employee Benefits Plans & Considerations	Estate Calculation & Valuation
4	Factors Affecting Financial Statements	Disability Insurance	Futures & Options	Penalties & Additional Taxes	Funding Considerations for Defined Benefit Plans	Planning for Incapacity
5	Time Value of Money	Law & Industry	Applied Portfolio Construction & Management	Tax Aspects of Securities	Management/ Tax Considerations of Contributory Funds	Federal Estate Tax Deductions
6	Debt and Savings	Auto/Liability Insurance	Diversification & Investment Strategies	Charitable Contributions	Social Security Considerations	Probate Considerations
7		Social Insurance	Cash Equivalent Considerations	Accounting Methods	Non-Qualified Deferred Compensation Plans/ Considerations	Liquidity Planning
8		Related Insurance Factors	Regulation of Securities & Markets	Social Security & Self-Employment Tax		Charitable Transfers
9			Insurance-Based Investments	Intrafamily Transfers		
10			Economic Considerations In Portfolio Construction & Management	Life Insurance Annuities		
11				Other Tax Issues		

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CFP Professional Education Knowledge Structure Maps

The detailed outcomes from each investigation were summarized in separate charts by CFP knowledge domain. For each matrix, the key ideas and their respective topics, accompanied by IBCFP topic identification numbers, were listed in the order that they emerged after the factor extraction and rotation phases. In addition, the CFP study guide assignments, developed by College Academics in conjunction with advisory committee input and feedback from the knowledge structure research, were listed in parentheses with the topics that they covered.

Due to the proprietary nature of the material contained in the resulting matrices, the actual charts produced were not included in this report. Instead, Table 11, designed with reference to findings from the CFP I study, was prepared to illustrate (irregardless of domain content) how findings could be utilized in the design of professional education instructional materials that could encourage meaningful knowledge acquisition.

In essence, the following map provides a comprehensive blueprint that can be utilized to (a) identify and emphasize key ideas and their components within a professional education knowledge domain, (b) determine and communicate relationships among topics to help students make sense of and develop accurate conceptions about new information and (c) specify linkages among topics to help learners relate new information to their prior knowledge and practice transferring that knowledge to novel situations.

Table 11. CFP I Key Areas, Topic Loadings and Study Guide Assignment Correspondence

CFP I : FUNDAMENTALS OF FINANCIAL PLANNING

Financial Planning Functions	Economic Concepts	Ethical, Regulatory, and Legal Issues	Factors Affecting Financial Statements	Time Value of Money	Debt and Savings
Topic #05 (A1)	Topic #08 (A8,9,10)	Topic #21 (A2)	Topic #15 (A7)	Topic #11 (A11,12)	Topic #10 (A4)
Topic #02 (A13)	Topic #09 (A8,9,10)	Topic #20 (A2)	Topic #14 (A5)	Topic #12 (A12)	Topic #16 (A2)
Topic #18 (A14)	Topic #04 (A3,4,5,6,7)	Topic #17 (A2)	Topic #13 (A13)	**Secondary Loadings**	Topic #19 (A14)
Topic #03 (A15)	Topic #07 (A8,9,10)	**Secondary Loading**	**Tertiary Loading**	Topic #07 (A8,9,10)	
Topic #01 (A1)	**Secondary Loading**	Topic #16 (A2)	Topic #19 (A14)	Topic #13 (A13)	
Topic #06 (A15)	Topic #10 (A4)				
Secondary Loading					
Topic #19 (A14)					

***(A#) = Study Guide Assignment Number**

DISCUSSION

The numerical relationship judgment technique led to the creation of an objective, expert-based knowledge structure for each CFP knowledge domain. In addition, the six types-of-topic-relationship categories utilized by College Academics provided information about how to develop meaningful lessons for the material to be learned in each CFP study guide. If relationships among some topics were found to be structural, for example, learners could be made aware of the underlying superordinate-subordinate hierarchy. Likewise, if topics had a procedural association, students could be instructed about the order and sequence of steps involved (see Donald, 1983).

It was recognized that a learner's transition from novice to expert status generally involved a progression from simpler to more meaningful learning behaviors (Anderson, 1985). Thus, findings from the six separate studies were approached with the following three ideas in mind:

- Initially, learners usually acquired domain-specific knowledge in a more-or-less rote fashion where isolated facts were interpreted according to and subsumed into preexisting relevant knowledge bases;

- Even if the resulting structures and interrelationships among the IBCFP topics made sense to experts, there were no guarantees that novices also would comprehend such organization and;

- Learning was not an additive activity but instead, consisted of gradual changes, where relationships among acquired factual information enabled the development of cognitive conceptual networks that facilitated understanding and higher-order problem solving (see Shuell, 1990).

The College's course developers did not view the knowledge structure research outcomes in isolation. The findings were reviewed in combination with both advisory committee input and personal professional judgment to elicit collective guidance in study guide development efforts. Thus, the research was rot intended to be a panacea for course design methodology. Instead, the findings presented in the actual knowledge structure charts offered concise views of how results from the research could assist in integrating the teaching of the IBCFP topics to enhance learner understanding. The ways in which the research outcomes could be utilized to bring together and to help make meaningful subject-matter content within a professional education knowledge domain have been addressed, as follows, with reference to the general findings presented in Table 11.

Domain Knowledge Structure

The expert-based knowledge structure that emerged from the CFP I topic-pair data complemented yet offered a more elaborate depiction of the domain (see Table 11), compared to the topic/subtopic list published by the IBCFP.

The 21 CFP I topics listed by the IBCFP are structured generally in either linear sequences or as separate units. Instructional materials designed according to knowledge organized in this fashion are likely to foster lower-level knowledge acquisition (i.e., chaining) because students are given primarily sequential and often isolated domain subject matter that is not linked clearly within and across discipline components to encourage conceptual knowledge development.

The arrangement of the topics which comprised factors (i.e., key ideas) within the CFP I knowledge structure chart also differed sequentially from that published by the IBCFP. As shown in Table 11, topics formed key ideas on the basis of how experts' content-relatedness perceptions revealed unique areas that were independent from one another and representative of the CFP I knowledge domain. These underlying, complex notions about the domain were not recognized readily when examining the chronological IBCFP topic list. Although the organization presented in the CFP I knowledge structure map as well as the IBCFP CFP I Topic/Subtopic list made sense, a greater integration of topics within (i.e., primary factor loadings) and across (i.e., secondary and tertiary factor loadings) the key areas for the CFP I knowledge domain was made possible through the research outcomes. This integration and linkage has been found to be related significantly to the development of high-quality learning outcomes (Van Rossum & Schenk, 1984).

Integration within Factors

The CFP I topic loadings indicated that even though some topics had loadings greater than .40 on more than one factor (i.e., secondary and/or tertiary loadings), topics overall correlated highly with only one primary factor.

In each study, the topics that clustered with one another were examined in at least three ways to help course developers be aware of the strategies that could help to encourage meaningful learning. First, the overall meaning or underlying theme communicated by topics that loaded highly on a factor was interpreted by subject matter experts. In most cases, experts indicated that factors were interpreted easily. Even so, it was not surprising that factors with eigenvalues only slightly greater than one were found to be more difficult to interpret by experts, compared to preceding factors that explained relatively higher proportions of the total variance.

The initial activity of identifying and interpreting key ideas based on topic loadings required experts to consider (a) where and how factors and their components fit into a particular CFP knowledge domain, (b) how novice learners might perceive factor labels and (c) expectations about learners' preexisting domain-specific knowledge. In addition, the relationship categorization exercise was intended to make Academics conscious of (a) topic interrelationships often taken for granted by experts and (b) the various learning strategies that could be considered to help learners make sense of and relate topics to support conceptual knowledge development. Considerable dialogue ensued between the primary investigator, trained in educational psychology, and each Academic expert within a particular CFP knowledge domain. Specifically, ideas were discussed about human-information processing, meaningful cognitive learning and the transfer of knowledge to novel problem-solving tasks.

Finally, the study guide assignment numbers accompanying the topics that clustered together, as shown in Table 11, also provided clues about how lessons could be linked to foster quality learning and transfer of domain content. Topics that formed key ideas, yet were covered across various study guide assignments, could be connected by interweaving what was taught in the earlier assignments with material covered in subsequent lessons. For example, in Table 11, the first factor (Financial Planning Functions) indicated that two topics covered in the CFP I Study Guide Assignment 1 (i.e., Topic #1 and Topic #5) could be revisited and/or connected to other topics that loaded on the same factor but were addressed in Assignments 13, 14 and 15 (i.e., Topic #2, Topic #18, Topic #19, Topic #3 and Topic #6, respectively). Likewise, the second factor in Table 11, "Economic Concepts", was comprised primarily of IBCFP topics covered acoss the CFP I Study Guide Assignments 8, 9 and 10. However, Topic #4 and Topic #10 (Assignments 3 through 7) also were tied into the Economic Concepts factor. Thus, facts and principles presented in the preceding assignments (i.e., lessons 3, 4, 5, 6, and 7) could be linked to the new information given in Assignments 8, 9 and 10 to enhance learner comprehension and encourage knowledge transfer.

In this manner, the topics that formed key ideas for the CFP I knowledge domain could be connected meaningfully within a factor by considering both (a) the accompanying study guide assignments that indicated when and where topics were addressed and (b) the types of relationships and learning strategies indicated in the preceding categorization exercise. The information, combined with the meaning communicated by each key idea that emerged from topic loadings, could be used to help establish additional connections in support of meaningful knowledge acquisition and the development of expert-like cognitive structures for learners within the CFP I knowledge domain.

Integration across Factors

The information presented in Table 11 could be used also to identify (a) topics that loaded significantly on more than one factor (i.e., secondary and tertiary loadings) and (b) the structure and components of the CFP I portion of a comprehensive review course.

In the first case, course developers initially had to determine the plausibility of secondary and tertiary loadings. Since rotation to simple structure was achieved more-or-less successfully in the six studies, topics usually loaded highly on only one factor. The only exception involved three CFP IV topics where primary loadings were marginal at best. In every study, however, lower yet significant (e.g., .40 - .60) secondary and tertiary topic loadings also were observed.

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CFP Academics reviewed the secondary and tertiary topic loadings and in most cases, judged them to have less-important yet valid connections with the other topics that defined the key idea underlying the factor.

Topics that had significant and valid loadings on more than one factor could be presented in course materials in the various ways that they might be encountered within a domain. For example, Topic #19 was covered specifically in the CFP I Study Guide Assignment 14. Yet, Topic #19 loaded significantly on three factors as shown in Table 11 (e.g., primary loading - "Debt and Savings", secondary loading - "Financial Planning Functions", tertiary loading - "Factors Affecting Financial Statements"). Although the topic was to be covered in only one study guide lesson, experts' judgments indicated three key idea areas where the topic was prevalent. Knowing how the topic functioned across the three factors, as determined by the kinds of relationships it had with the other topics that clustered on each factor, could be useful in helping learners establish complex links across areas within a domain.

The utilization of secondary and tertiary topic loadings needs to be judged with reference to (a) what would be involved in making the best use of available information and (b) the potential benefits that could result from efforts to establish complex views about a discipline. In most instances, it seems desirable that course developers have as many resources as possible to assist them in their efforts to design instructional materials that can help learners acquire domain-specific expertise.

Findings from the CFP I knowledge structure study also could be utilized in the design of a comprehensive CFP I-VI review course. Overall, the six resulting expert-based knowledge structures organized the 175 IBCFP topics into 50 key areas (see Table 10). The 50 key areas accompanied by (a) their respective topics, (b) information about how topics were related both vertically (within a factor) and horizontally (across factors) and (c) study guide assignment numbers, supplied an excellent framework for the design of a capstone course. Furthermore, students at the review course stage in the College's CFP Professional Education Program should be capable of comprehending more like experts, similarities and relationships among topics across the six knowledge domains. For instance, what previously might have been conceptual yet very specific ideas contained within the CFP I knowledge domain could be integrated, on a larger-scale, by using the comprehensive blueprint shown in Table 11 in conjunction with the other knowledge structure matrices obtained for the CFP II-VI domains.

In summary, each matrix provided concise, expert views about (a) predominant key idea areas within the College's CFP Professional Education Program, (b) the organization of financial planning ideas and topics and (c) the coordination and sequencing of discipline content. This information could provide the guidance needed to design a comprehensive review course where the content of each CFP knowledge domain and accompanying learning objectives could be structured to enhance the retention and transfer of relevant knowledge required for successful financial planning problem solving.

CONCLUSION

The determination of the structure of knowledge for each CFP knowledge domain was undertaken to provide one source of guidance in the design of the College's CFP Professional Education study guides. Based on meaningful cognitive learning theory, the research was conducted with reference to the widely-supported premise that high-quality learning involves an active, constructive and goal-oriented process in conjunction with a learner's inclination to make sense of and relate new information to relevant prior knowledge in memory (see Shuell, 1990). This notion, combined with over two decades of educational research findings that have confirmed collectively the value of understanding rather than memorizing content of a domain, supported pursuit of the six CFP knowledge structure investigations.

Quantitative and qualitative structural knowledge assessment procedures were synthesized to produce a systematic, practical technique for (a) inferring the organization of knowledge (i.e., the IBCFP topics) for each component of the College's CFP Professional Education Program and (b) communicating interrelationships among the IBCFP topics to promote conceptual knowledge development. Both types of information were deemed essential for the design of instructional materials that would encourage successful financial planning problem solving, knowledge transfer and favorable performance on examinations aimed at assessing higher-order thinking behavior.

Six separate studies verified both the validity and the utility of the procedure in fulfilling the primary objectives to determine the organization of as well as the relationships among the IBCFP topics within each CFP knowledge domain. It was recognized, at the onset, that the College's distance-based model of instruction limited opportunities to ascertain learner disposition and motivation. The research confirmed, however, that the structures and strategies identified to help students (a) make sense of the IBCFP topics and (b) relate the IBCFP topics to promote conceptual understanding of the financial planning discipline, generally were very consistent with current course development practices at the College. This feedback, combined with the finding that both in-house and outside experts' judgments converged consistently, provided evidence that supported further the existing credibility earned by the College's materials.

In summary, the detailed outcomes provide a comprehensive framework that Academics can continue to utilize and build upon in both the development of CFP study guides and the design of a CFP I-VI review course.

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