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ABSTRACT

This paper reports preliminary research into the nature of relative expertise in economic problem solving. The first section briefly describes why such research is needed in the context of research on expert and novice problem solving. It also presents the problem explored in this study in the context of the existing research. Subsequent sections present the methods, results, and conclusions of the study. The researchers examined literal transcripts generated from the "talk-aloud" protocols of 28 participants responding to three economic problems. Each sub-group contained four participants: (1) high school students who had taken economics and those who had not taken economics; (2) undergraduate economics majors and non-majors; (3) graduate students in economics; and (4) Ph.D. economists employed in public and private forecasting and academic Ph.D. economists. The study employed a causal-comparative design with members of the seven sub-sample groups identified by the researcher. Three economics problems were employed in the study with several phases of data gathering involved in the analysis of data. Extensive charts and graphs accompany the text. Contains 32 references. (EH)

The Nature and Constructs of Relative Expertise in Economic Problem Solving: Preliminary Findings

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Introduction

Economic educators have long emphasized that the teaching and learning of economics should result in the increased willingness and ability of students to use the discipline of economics in solving problems, both personal and social. Given this emphasis, the focus of much research in economic education has been on the factors affecting student understanding and application of economic concepts. However, recent research calls into question the adequacy of this approach as a means to explore the relationship between educating for economic understanding and the goal of better economic problem solving. Some researchers are investigating the literature concerning schemata and expert problem solving drawn from cognitive psychology (Miller and VanFossen, 1994; VanSickle, 1992 and VanSickle and Hoge, 1991), which seems to hold promise for linking economic education and economic problem solving.

A previous study by Miller and VanFossen (1994) has described key differences between expert and novice problem solvers in economics. However, explicating the distinctions between novices and experts only begins the quest to understand how one acquires expertise in economic problem solving and, further, to promote expertise through economic education. A crucial step is to understand relative expertise, that is differences in expertise not just between experts and novices, but among individuals at various points along the path to expertise. Indeed, as the characteristics of relative expertise in economic problem solving become known, it may be possible to design curriculum in economic education that might better assist students in moving closer to this level of problem solving ability.

This article reports preliminary research into the nature of relative expertise in economic problem solving. The first section briefly describes why such research is needed in the context of research on expert and novice problem solving. It also presents the problem explored in this study in the context of the existing research. Subsequent sections present the methods, results, and conclusions of the study.

Context of the Research and the Problem

Economic Education and Problem Solving

Since at least the 1961 *Report of the National Task Force on Economic Education*, economic educators have long contended that economic education should develop the ability of students to use economics to solve problems, a goal that has been reiterated many times over the years (Saunders, et al., 1993; Buckles, 1989; Miller, 1988; Schug, 1985; and Symmes and Gilliard, 1981). Moreover, at least one important result of this enhanced economic problem solving ability should be more effective and responsible citizenship (Miller, 1991 and 1989; and Brenneke, 1992). Indeed, increasing democratic citizens abilities to engage in more effective economic problem solving is the *raison d'etre* of economic education.

Thus the rationale for economic education posits a chain: that more and better economic education will lead to greater student understanding of economics which will lead to better económic problem solving resulting in more responsible citizenship (Miller and VanFossen, 1994). Of the links in the chain, the first -- the relationship of economic education to greater student understanding of economics -- has received the most attention, with particiular emphasis on studies of the impact of economic instruction on scores of students on standardized economics tests (See Walstad and Soper, 1991, for numerous examples). Until very recently, research on the relationship of understanding to problem solving, the second link, was largely confined to studies comparing students' aned economists' opinions on various economic issues. The third link has been explored not at all.

There is, however, reason to question whether competence in economics should be equated with understanding of economic concepts and, further, whether knowledge of economic concepts alone is sufficient, in and of itself, to lead to greater expertise in economic problem solving. Research in expert and novice problem solving and schema theory suggest the need for a more complete conceptualization of economic knowledge. "Indeed the notion of economic knowledge as highly developed *schemata* (interconnected cognitive structures) suggests a redefinition of economic knowledge as inextricably intertwined in a network that includes the linkages among bits of economic knowledge and the specialized procedures for using that knowledge" (Miller and VanFossen, 1994).

Expertise and Schema

In studies in fields as diverse as radiology, physics, and, political science, differences in how experts solve problems have been shown to depend upon more than knowledge of the content of their respective disciplines. To take a specific example, Lesgold, et al. (1981) found that experienced radiologists were nearly always more successful in their diagnoses than recent interns, despite nearly equal content knowledge. Van

Sickle (1992) has noted that experts possess more declarative, procedural, and schematic knowledge than non-experts.[1] Of these, only declarative knowledge refers to the knowledge of the specific body of content. Procedural knowledge is "the knowledge of how to" (Voss, 1989). Experts' more highly developed schemata point to greater integration among procedural and declarative knowledge.

Miller and VanFossen (1994) summarized ten attributes of expert problem solvers drawn from the research literature. In a recent study, in which they developed a model to assess differences among experts and novices in economics, Miller and VanFossen found evidence that these attributes exist in the domain of economics. The attributes they listed (See Figure 1) included differences in declarative and procedural knowledge as well as more highly developed specialized schema.

1. Experts excel mainly in their domain.
2. Experts perceive relevant patterns in their domains. These meaningful patterns assist in the application of domain-specific knowledge.
3. Experts see and represent problems at a deeper, more principled level than do novices.
4. Experts spend more time on problem representation. Experts employ a 'work forward' strategy that requires greater time allocation for problem identification before the application of theory or knowledge.
5. Experts have strong self-monitoring and self-evaluation skills.
6. Experts demonstrate more flexibility in the process of problem solving.
7. Experts identify models as tools in problem solving rather than real-life processes.
8. Experts possess more domain-specific, declarative knowledge.
9. Experts have extensive procedural knowledge.
10. Experts have more highly developed specialized *schemata* than novices.

Figure 1. Attributes of Expert Problem Solvers (Miller and VanFossen, 1994)

[1] Miller and VanFossen have pointed out that the term "schematic knowledge" is potentially confusing since it implies that it is a component of domain specific knowledge that is somehow separate from declarative and procedural knowledge. They argue that it is perhaps better to conceive of this as more highly developed domain specific schemata, the integration of declarative and procedural knowledge.

Expertise and Economic Education

That there should be evidence that economic expertise depends on more than just knowledge of economic concepts has been implicit in much of the activity of economic educators over the years. For instance, Buckles has written: "Our teaching of economics can be most effective if we focus on the ideas that economics is a 'method' an 'apparatus' and a 'technique'" (1991, p. 24). This statement implicitly assumes the existence of something like procedural knowledge. Much of the writing about the need or rationale for economic education has discussed economics in similar terms. Moreover, some of the materials developed by economic educators distinctly emphasizes employing the "method" of economics, including, for example, *Mini-Society* (Kourilsky, 1983), *Capstone: The Nation's High School Economics Course* (Reinke, et al., 1989) and *United States History: Eyes on the Economy* (Schug, et al., 1993).

If this has been the case, why has so little research been devoted to the acquisition of expertise in employing the "method" of economics? While some studies have attempted to highlight the differences between experts and novices, there have been none depicting the nature of *relative* expertise, or any other such points along the path to expert status. Moreover, and more importantly, no research has been conducted about the most effective means of instruction in developing these various levels of expertise in economic problem solving.

If the goal of economic education is more effective economic problem solving, it is important to know how students become more effective problem solvers and what instructional strategies and curriculum materials produce greater expertise. "Toward this end, it is crucial to know how well the patterns of economic reasoning conform to those of economic experts. Economic educators might then be better able to design curriculum and instruction that addresses the development of economic reasoning based on a firm research foundation" (Miller and VanFossen, 1994). This study is intended to be a first effort in illuminating the path to economic expertise.

Models of the Nature and Construct of Relative Economic Expertise

In the absence of research, one might conceive of any number of possible models that depict the nature and construct of relative expertise in economic problem solving, each with attendant implications for instruction and curriculum design (See Appendix B). For instance, one possibility is a simple continuum.

As students acquire more domain-specific declarative knowledge, they progress in regular increments toward greater expertise in economic problem solving. This model seems unlikely given research on schema theory (See Torney-Purta, 1991, for a summary of this line of study), but it coincides best with the much of the teaching and research in economic education. It implies that material designers and teachers can concentrate on teaching economic concepts and content, and that we can assess expertise by measuring how well students have grasped economic concepts.

A more complicated construct is that greater instruction in economics has little noticeable impact on expertise in problem solving until one or more threshold levels are reached. One might think of this as a "discontinuous continuum," wherein a student moves ahead on the declarative knowledge dimension of expertise without making much discernable progress in problem solving until reaching a threshold, where a "leap" in problem solving ability occurs. That such a leap is plausible is suggested by the knowledge integration aspect of schema theory (VanSickle, 1992; Torney-Purta, 1991; VanSickle and Hoge, 1991) . The student suddenly "gets it" as disparate economic ideas and notions of procedure become incorporated into her or his schemata. This implies the need to study how this knowledge integration takes place and what instruction and materials best promote it.

Another possibility is suggested by the attributes of expertise as drawn from existing cognitive research (Glaser and Chi, 1988; Chi, Glaser and Rees, 1982). In this model, students proceed--probably at different rates--down multiple dimensions of the attributes of expertise in problem solving. The third model in Appendix B shows one such representation that includes dimensions for problem representation and procedural and declarative knowledge--three of the ten attributes listed by Miller and VanFossen (1994). This model suggests that researchers should concentrate on understanding how each of the attributes is developed with an eye toward instruction that promotes their progress.

Perhaps the path to expertise is curvilinear. As depicted in Appendix B, there might be a series of levels of expertise with some distribution of, for example, standardized test scores at each level. Greater expertise in problem solving might at first respond slowly to successive increments of declarative knowledge. Later, the path of expertise turns more sharply upward as students build more highly developed schemata. While the depiction in Appendix B shows this possibility as a curve concave to the xaxis, a curve convex to the axis is also possible. The latter implies rapid progress in the acquisition of expertise with diminishing returns setting in at some point. The former implies that there might need to be substantial knowledge in economics before there is much noticeable improvement in economic problem solving. Perhaps researchers would then focus on techniques to change the shape of the curve.

Statement of the Problem

Obviously, there are other possible models. The significant point for this study is that while we know something of the differences between expert and novice problem solving in economics (Miller and VanFossen, 1994; Son and VanSickle, 1993; VanSickle, 1992), we know almost nothing of how expertise is acquired and the relationship of economic education to acquisition of expertise. This study is intended as a first step in gaining insight into the nature and construct of relative expertise in economic problem solving. One necessary and significant aspect of the study is the identification and analysis of indicators useful in assessing relative expertise.

Method

The researchers examined literal transcripts generated from the 'talk-aloud' protocols of twenty-eight participants responding to three economic problems. Each of the following sub-groups contained four participants: high school students who had not taken economics (HS NOECON), high school students who had (HS ECON), undergraduate non-majors (UND NOECON), undergraduate economic majors (UND ECON), graduate students in economics (GRAD), Ph.D. economists employed in public and private forecasting (PHD-FIELD) and academic Ph.D. economists (PHD-UNIVERSITY).

Research Design

The study employed a causal-comparative design. According to Fraenkel and Wallen (1990), causal-comparative designs attempt "to determine the cause or consequences of differences that already exist between groups or among individuals" (p. 305) and also "involve comparing known groups who have had different experiences to determine possible causes or consequences of group membership" (p. 15). Causal-comparative research employs the static group comparison design (Campbell and Stanley, 1963). For this study, the group difference variable was defined as expected level of relative expertise in economic problem solving. This expectation was indicated by the level of formal economic education attained by a participant (the variable PARTLEV). Figure 2 provides a schematic that represents the static group comparison research design used in the current study.

Group	Independent Variables	Dependent Variable
I	13 relevant indicators of expertise, (group characteristics)	relative expertise in economic problem solving
(Groups II-VI)		
IIV	13 relevant indicators of expertise, (group characteristics)	relative expertise in economic problem solving

Figure 2. Design of the Current Study

The static group comparison design posed several significant problems with respect to questions of internal and external validity. Among these were: (1) lack of randomization, (2) inability to manipulate independent variables, (3) subject selection and (4) data collector bias (McCracken, 1991; Campbell and Stanley, 1963).

The current study addressed the lack of randomization and subject selection issues by creating homogenous sub-sample grouping and by employing purposive sampling techniques. Fraenkel and Wallen (1990) noted that one way to control extraneous variables, outside of random selection, was to "find, or restrict, one's comparison to groups that are homogenous on that variable" (p. 310). Therefore, the current study used an across group comparison based upon participants' expected level of expertise in economic problem solving as indicated by the level of formal economic education attained. Further, sub-sample group members were relatively equivalent with regard to level of formal economic education and economic experience attained. Moreover, as it was not a goal of this study to engage in an experimental design, the issue of manipulating an independent variable was unimportant.

Finally, the question of data collector bias in the analysis of transcribed responses was addressed by having a second rater examine and code a random sample of the respondents' protocols. This rater was extremely familiar with this line of study and was trained using the coding rubrics outlined in this chapter. The results of the second rater's coding indicated a very high degree of correlation between the researcher's coding and that of the second rater (correlation coefficient = .8341; $p < .01$). These results may be interpreted as partial validation of the coding process employed by the researcher in this study.

Selection of Participants

Members of the seven sub-sample groups were identified, either directly, or indirectly, by the primary researcher. For example, the academic Ph.D. economists (PHD-UNIVERSITY) were approached based on suggestions from a member of the economics faculty at The Ohio State University (OSU) and were all members of the OSU economics faculty.

A similar process was undertaken to secure the participation of the non-university Ph.D.'s (PHD-FIELD). A membership list of the Columbus Association of Business Economists (CABE) was used to identify participants. The four economists who participated were employed in either public or private economic forecasting or analysis.

A list of second- and third-year OSU graduate students in economics (GRAD) was used to generate a mailing to which four OSU graduate students (three second-year and one third-year) responded and subsequently participated in the study. A list of undergraduate economics majors at OSU was used to produce a mailing, out of which four participants were identified. Two of the participants were of junior standing, one was a sophomore, and one was of senior standing.

The undergraduate, non-economic major participants were members of a social studies education methods course taught by one of the researchers. Three of the four participants had never taken a formal economics course (high school nor university). The fourth participant had taken, as part of a Masters' Degree program in social studies education, a course titled Curriculum and Instruction in Global Economics, but no other formal economics courses.

The four high school economics students were members of a senior-level economics class that the primary researcher observed during winter quarter, 1992. The four were selected by the researchers, in conjunction with the student's classroom teacher, on the basis of their performance throughout the one-semester course. The students had just completed the economics course when the data were collected. It should be noted that this course was taught by a veteran high school teacher who had attended several workshops on teaching high school economics and whose course was based upon the National Council on Economic Education's Framework for Teaching the Basic Concepts (Saunders, et al., 1993), considered by many to be the major economics curriculum in use today.

This high school economics teacher also selected the four student participants who had not taken high school economics. These four were also seniors and data on this sub-sample group was also collected at the end of the term. Thus, in a broad sense, the two high school student sub-groups were relatively equivalent except in formal economic education and economic experience.

Data Collection

Data collected and analyzed for the current study took the form of transcribed participant responses to three pre-determined economic problems. These responses, or protocols, were audio-taped and then literally transcribed by the primary researcher. This data collection strategy was well supported by much of the previous expert problem solving research in cognitive psychology (See, for example, Chi and Glaser, 1980; Glaser and Chi, 1982; and Lesgold, et al., 1981 and Voss, et al., 1983, 1989). The so-called 'talk-aloud' strategy used in the study asked participants, to the best of their ability, to verbally express their thought processes during the problem solving activity. That is, as participants dealt with various domain-specific problems, they were encouraged to "put into words" the processes they engaged in while addressing these problems.

Participants were given a set of standardized instructions (See Appendix B) that allowed one minute for the respondent to familiarize themselves with each problem. The instructions explicitly encouraged respondents to draw any diagrams or graphs that might help them in dealing with the problem in question. No pre-set time limit was suggested by the instructions. Rather, the primary researcher stated to each participant that they should begin when ready and continue speaking until they had, to their own satisfaction, dealt sufficiently with the problem. Participants were told to continue analyzing the problem until they felt certain they had exhausted their input and felt comfortable with their response. This process was repeated for each subsequent problem.

Three economic problems--based upon those constructed by Miller and VanFossen (1994)--were employed in the study. Each of these represented one of three broad areas of economic theory: microeconomics, macroeconomics and international trade. As Miller and VanFossen noted, these problems "were crafted to allow the researchers to detect important differences in economic problem solving that might be specific to the individual problems" (p. 15). Further, Miller and VanFossen believed, some issues of expertise in problem solving may be domain-specific or idiosyncratic. Thus, it was essential to develop a series of economic problems that would generate the broadest range of responses and therefore demonstrate the widest range of expertise with respect to economic problem solving. The problems developed were:

1. Suppose Congress were to double the current minimum wage of $4.25 an hour to $8.50 an hour. Analyze the economic impact of this policy and discuss whether you believe such a policy would be a good idea or not and why (microeconomic focus).

2. In 1929, the so-called Great Depression began. Discuss what you believe caused the Great Depression and what, if anything, the federal government should have done to keep economic conditions from deteriorating so badly (macroeconomic focus).

3. Trade among nations is a perennial economic issue. Suppose that you are the recently appointed Secretary of Commerce, and assume that our trade deficit has been growing (the US has been buying more goods and services from foreign countries than they have been buying from the US). As the Secretary of Commerce, your problem is to design and defend the new administration's trade policy. How will you respond (international trade focus)?

Each respondent's transcribed protocol was analyzed by the primary researcher. The first phase of analysis involved the coding of protocols for eight variables: absolute number of relevant statements (STATE), percentage of relevant statements (RELPER), number of economic concepts (CONCEPTS), number of economic models (MODELS), number of concept maps (CONMAPS) and expert ratio profiles (ERP) for causal, (CAUSERP) propositional (PROPERP) and problem representation statements PROBERP).

These eight variables, along with the five Pitt Problem Solving Coding System variables outlined below, constituted a set of relevant indicators of expertise in economic problem solving. These indicators were developed through a content analysis of key studies in expert-novice problem solving (See, for example, Voss, et al., 1989; Glaser and Chi, 1988 and Glaser, 1987) and from a pilot study conducted to develop a model for assessing expertise in economic problem solving (Miller and VanFossen, 1994).

The number of relevant statements (STATE) made by a participant during a response was counted. For the current study, a relevant statement was defined as one complete sentence in a respondent's protocol that contained relevant economic information or that specifically addressed the problem under consideration. Similarly, the number of non-relevant statements were also counted. A ratio of relevant-to-non-relevant statements was then calculated (RELPER).

The number of economic concepts (CONCEPTS) used by a respondent within a protocol were counted. For the current study, an economic concept was defined as a class of economic phenomenon that possessed common characteristics and/or attributes and that also noted linkages to other, broader more inclusive economic concepts. Moreover, for the sake of the current study, economic concepts were deemed those concepts whose relation to economic theory was generally accepted, or were considered low-inference concepts. A list of the economic concepts employed by participants in the current study may be found at Appendix C.

Data were collected regarding the total number of economic models (MODELS) used in a participant's protocol. The primary researcher coded and counted the number of times a participant used various economic models during a response. During this data collection, an economic model was considered to be a complex series of conceptual connections, assumptions and rules for rendering economic interaction within a specific area of the domain of economics. Examples of such models include: general supply and demand models, aggregate demand and aggregate supply models, exchange rate markets, public choice models and industrial organization (I-O) models. A complete list of the economic models employed by participants in response to the three economic problems is located at Appendix D.

The primary researcher collected data on the use of economic concept maps (CONMAPS) by first identifying the economic concepts used in a protocol by a respondent. A conceptual network was defined as an interrelation among economic concepts such that the invoking of one economic concept led to the invoking of one or more other economic concepts. In addition, it was assumed that the use of a concept map by the respondent was analogous to the invoking of a specific cognitive structure--much like *schemata*.

Therefore, the concept maps took on different levels of complexity as they were associated with the explication of a particular economic model. For example, a discussion of the concept of *supply and demand* required a discussion of *price* and therefore *equilibrium price*, and so forth. However, this was a general market model. A second concept map might involve linking such a general model with a specific example--a *labor* market--and therefore *price* with *real wage rates*.

Given this, the researchers coded an economic concept map as the following: a low-inference connection between two or more economic concepts situated somewhat contiguously within the context of a protocol and used in the explication of an economic model. Stated another way, if the respondent connected (or invoked) one or more economic concepts shortly after invoking a prior concept, and within the framework of an economic model, and this connection was essentially correct economically, the conceptual string created by the respondent was coded as a concept map. The following excerpt from a respondent's protocol is an example of such a concept map:

> "So this is *short run*, very *short run*, it is going to happen overnight. The there will a gap in *quantity of labor demanded* and *quantity of labor supplied* with *unemployment resulting...*"

For this respondent, the use of the concept *short run* was followed closely by the invoking of three other, related concepts. These concepts were related in the sense that, economically, the concept of *short run* implies no time for markets to adjust to changes in factor inputs or other shocks and, therefore, the issue of "gaps in quantity of labor demanded..." occur only in the short run. Moreover, this map is directly related to the application of a generalized market model. This case is a more sophisticated example, as the issue of time, and its relationship to the market, is implied. Furthermore, this concept map is directly related to the first concept employed by the respondent: *short run*.

Data concerning respondent's problem representation statement, causal statement and propositional statement Expert Ratio Profiles (ERP's) were coded using criteria previously employed by Miller and VanFossen (1994). Statements were classified as problem representation (PROBERP) if they demonstrated an attempt to re-order or re-construct a problem in an effort to discover connections, or to sort the problem into more accessible algorithms. Further, problem representation statements demonstrated some level of planning on the part of a respondent with respect to the problem and processes used to address the problem. The following excerpt from a respondent's protocol illustrates a problem representation statement:

> "...if you're living in a world of fixed exchange rates, that sets up one set of problems. If you're living in a world with flexible exchange rates that sets up a different set of problems."

Similarly, statements were coded as propositional (PROPERP) If they contained "links...which...resembled the 'if' part of an 'if...then' statement" (Miller and VanFossen, 1994, p. 17). Thus, statements that represented some level of logical connection between an economic condition and an economic outcome were coded as propositional. The example used above to illustrate problem representation is also an example of a propositional statement. A second example of such a prepositional statement is "if you double the minimum wage, that means that more people will not be employed."

Finally, statements that clearly established links of causality (CAUSERP) were coded as causal statements. These causal links were defined as statements that made an 'A causes B' distinction. Although similar in nature to the propositional statement, the causal statement involved the demonstration of a more direct economic connection rather than a hypothesis for examination. For example, a respondent stated that the income tax increase of 1932 led to a fall in disposable income and therefore a drop in aggregate demand. One can classify such a statement as fitting the 'A causes B' model.

The second phase of analysis undertaken by the researcher involved coding the transcribed protocols in terms of the Pitt Problem Solving Coding System (PPSCS). First developed by Pitt (1983), the PPSCS (See Figure 2) coded qualitative data, such as the current study's transcripts, into one of six categories of strategies used in problem solving (general problem solving, feedback, pattern extraction, hypothetico-deductive, evaluation and heuristics) by integrating constant comparison analysis (Glaser and Strauss, 1967). Pitt (1983) argued that the coding system developed in her study provided a "comprehensive, empirical instrument to code heterogeneous verbal protocols in terms of the types of processing function each verbal proposition represents" (p. 551).

Pitt (1983) provided operational definitions for each of the six coding classifications in the PPSCS. For the purposes of the current study, *general problem solving* strategies included defining an initial state of the problem, defining the goals involved, and being able to identify necessary data needed in solving a

General Problem Solving
SR10. Define initial state
SR11. Define goal state
SR12. Identify data needed

Feedback
SR17. Identify feedback
SR18 Tag new information
SR19 Organize new information

Pattern Extraction
SR22. Extract patterns from data
SR23. Summarize relevant patterns

Hypothetico-deductive
SR 7. Formulate hypothesis
SR 8. Define predictions
SR20. Match data to predictions
SR21. Determine truth values of predictions

Evaluation
SR 2. List assumptions
SR 4. Select evaluative criteria
SR 5. Assign priorities
SR 6. List relevant information
SR15. Edit algorithm

Basic Heuristics
SR 1. List given information
SR 3. List questions
SR 9. Select questions
SR13. Identify set of available algorithms
SR14. Select algorithms
SR16. Execute algorithm
SR24. Output conclusions

Figure 2. Components of the PPSCS Model: Problem Solving Strategies and Subroutines (SR)(Pitt, 1983)

problem. *Feedback* strategies identified and incorporated new information as it became available during the problem solving process. *Pattern extraction* strategies referred to the identification of relevant patterns, symmetries or regularities in the assembled data. *Hypothetico-deductive* strategies involved the formulation of hypotheses, engaging in predictions and analyzing the validity of these predictions. *Evaluation* strategies suggested that problem solvers select evaluative criteria, assign priorities, and revise the problem solving strategy based upon the evaluation. Finally, Pitt identified a sixth category: *basic heuristics. Basic heuristic* strategies represented an abbreviated heuristic that can suffice for simple, familiar problems. This classification of strategies is more complex than simple trial-and error, yet is too simplistic for more complex problems. For purposes of the current study, however, data were coded on only the first five categories as the researchers believed that the *basic heuristics* category generated data that was very similar to the ERP data already calculated for each participant.

Using the coding classifications outlined briefly above, and the constant comparison analysis technique, the researcher coded each protocol using the PPSCS. Mean levels for each PPSCS variable were then calculated for each of the seven sub-sample groups.

Data Analysis

The study employed the use of inferential statistical analysis techniques in spite of the very small sample size that would appear to violate basic assumptions necessary for the use of these techniques. However, Kerlinger (1973) concluded that:

> "[U]nless there is good evidence to believe that the populations are rather seriously non-normal, and that variances are heterogeneous, it is usually unwise to use a non-parametric statistical test in place of a parametric one. The reason for this is that parametric tests are almost always more powerful than non-parametric tests" (p. 287).

Further, Kerlinger stressed, the *F* distribution is relatively insensitive to the shape of the distribution in the parent population and that unless the evidence is obvious that the variances are so heterogeneous as to be easily seen, the impact on the *F* test will probably be negligible. Kerlinger concluded that, even if the first two assumptions are violated, the *t*- and *F*-tests will be highly accurate. Harnett (1971) concluded that the "robust" nature of these distributions implied that their usefulness extended to conditions that do not meet the necessary basic assumptions (p. 173).

In addition to this evidence, the study's use of a purposive sampling techniques added further support for the use of inferential statistical analysis. The researcher deliberately sought to identify members of the seven sub-sample groups for whom claims of representativeness might be easily defended. Indeed, close examine of one of these groups (the high school economics students) should provide the necessary insight in this case.

The high school economics students had, as noted earlier, an a very well-trained high school economics instructor. This, coupled with the fact that the curriculum for the course was derived from the National Council on Economic Education curriculum, implied that the students' experience was certainly no worse than any other high school economics course, and perhaps even better than most. Indeed, it can be argued, that these students' experience was not easily recognizable as "seriously non-normal" in any sense.

Therefore, the researchers employed inferential, parametric techniques in an effort to describe more completely the nature and constructs of relative expertise in economic problem solving. However, the researchers wish to acknowledge the assumptions that have not been met and to state explicitly that the use of these techniques should not be construed as an attempt to broadly generalize to any population or group other than that described at length within the context of the report.

The first level of analysis conducted in this study involved the calculation of sub-sample group means and standard deviations for each of the 13 variables under investigation. Further, these means were compared using one-way analysis of variance (ANOVA) to determine if the means for each of the sub-sample groups differed significantly from the means of the other six sub-sample groups. The one-way application was selected because the respondents differed along only one factor of interest; namely, the level of expected expertise (the variable PARTLEV).

For the second level of analysis, the data on each of the thirteen variables were standardized for the sample by re-configuring the variable into absolute rankings. These rankings were used to calculate a mean ranking for each group across all variables. A correlation analysis was conducted on this rank data to determine if a relationship existed among any of the variables in question--including the rank order and mean ranking transformations--and the level of formal economic education of the participants (PARTLEV).

Results

Statistical Significance and the Current Study

There is some debate concerning the issue of statistical significance versus practical significance in research in the social sciences and especially within education. McCloskey (1993) argued that "'statistically significant' does not mean 'substantively significant'" and that these two types of significance may have "nothing to do with each other" (p. 360). In this, McCloskey echoed Kruskal's (1968) line of argument that "it is easy to be over conservative and throw out an interesting baby with the nonsignificant bathwater...lack of statistical significance at a conventional level does not mean that no real effect is present" (p. 240). Indeed, Kruskal went on to note the "statistical significance of a sample bears no relationship to the possible subject matter significance" (p. 240).

The researchers were fully aware that significance tests are attempts to determine whether a sample is large enough to ensure approximately equivalent results from subsequent samples. As such, these tests are, in effect, direct functions of sample size (take, for example, the t-statistic, where t is determined using the standard error of the mean which is a direct function of n). Thus, results that have not proven to be statistically significant for the following analysis might plausibly result in significant results given a larger sample.

The researchers believed that the study generated some intriguing results that did not meet the stringent requirements for statistical significance, but were nonetheless essential for developing a deeper understanding of the nature and constructs of relative expertise in economic problem solving. Therefore, the current study reported results that were, in the judgment of the researchers, statistically significant, practically significant, or both.

The Nature and Constructs of Relative Expertise in Economic Problem Solving

The research question investigated by the current study was the following: Based on a sample range of economic problem solvers, what is the nature and construct of relative expertise in economic problem solving? By comparing sub-sample group means and standardized rankings, it was possible to state explicitly what one sub-sample group looked like relative to the other sub-sample groups. Therefore, the purpose of this line of analyses was to provide a description of how sub-sample groups differed across the thirteen variables, identified as relevant indicators of expertise, relative to other sub-sample groups.

For purposes of discussion, high school students with no formal economic education are Group 1 (or HS NONECON), high school economics students Group 2 (or HS ECON), undergraduate students Group 3 (or UND NOECON), undergraduate economics majors Group 4 (or UND ECON), graduate students in economics Group 5 (or GRAD), Ph.D.'s not affiliated with OSU Group 6 (or PHD-FIELD) and OSU Ph.D. economists are Group 7 (or PHD-UNIVERSITY).

Relevant Indicators of Expertise in Economic Problem Solving

Number of Relevant Statements (STATE). The mean number and standard deviations of relevant statements used by respondents, according to level of formal economic education and experience, is presented in Table 1. The data presented here, and for all subsequent variables, reflect the sub-sample group means across all the three economic problems. The means reported here were calculated for each of the seven sub-sample groups and not for each of the three economic problems within each sub-sample group. A decision was made to collapse the data in this manner after a one-way analysis of variance indicated no significant difference in the means of sub-sample groups when compared across problems. That is, there was no significant difference among the means for each of the variables considered, and across each of the sub-sample groups, for the three problems used. Therefore, unless otherwise noted, discussion of the data analysis in this section refers to combined means from each of the three economic problems.

The data indicated a difference in number of relevant statements made for each of the seven sub-samples groups. A one-way analysis of variance (all ANOVA results are summarized in Table 1) indicated that the Ph.D.. economists (PHD-OSU, PHD-FIELD) made significantly more statements than the first four groups (HS-NO ECON, HS-ECON, UND-NO ECON, UND-ECON), and non-university Ph.D.'s made significantly more statements than the first five groups [$F(6,77) = 13.6$, $p=.05$]. For this sample, no significant difference existed between the mean number of statements made by high school economics students and high school students who had not taken economics. Further, no significant differences existed in the number of statements made by high school economics students, undergraduate students and undergraduate majors in economics.

While the results were not all statistically significant, it was nonetheless interesting to note that both groups of Ph.D. economists used nearly twice as many relevant statements as the graduate students and three times the number made by the undergraduate majors. The difference between the number of statements made between both high school groups was marginal. Similarly, little difference existed between the undergraduate economics majors and non-majors. These results implied the number of statements made by the high school and undergraduate economics students were only marginally greater than counterpart groups. The data also indicated a substantial positive relationship (correlation coefficient =.68; $p<.01$, See Table 2) between a participant's level of formal economic education and the number of relevant statements used to respond to one of the three economic problems.

Percentage of Relevant Statements Used (RELPER). The mean percentages, out of the absolute number of statements used, of relevant statements employed by respondents according to level of formal economic education and experience is presented in Table 1. A one-way analysis of variance suggested that the Ph.D. economists (Groups 6 and 7), the graduate students. (Group 5), the undergraduate majors in economics (Group 4) and the undergraduate non-majors (Group 3) used a significantly greater percentage

Table 1
Summary Statistics and ANOVA Results by Sub-sample Group

Variable		Group: HS NOECON	HS ECON	UND NOECON	UND ECON	GRAD	PHD-FIELD	PHD-UNIVER.
STATE								
	μ*	3.42^{a}	5.67^{ab}	8.83^{ab}	9.33^{ab}	15.58^{b}	27.08^{c}	24.67^{bc}
	SD	1.62	3.67	3.83	2.10	4.60	16.88	13.77
CONCEPTS								
	μ	2.08^{a}	3.16^{a}	7.67^{ab}	7.92^{ab}	21.75bc	37.83^{c}	30.33^{c}
	SD	1.24	1.85	5.31	2.23	7.81	26.80	17.83
RELPER								
	μ	.55	$.71^{a}$	$.79^{ab}$	$.90^{bc}$	$.94^{bc}$	$.93^{bc}$	$.96^{c}$
	SD	.17	.20	.13	.11	.07	.05	.04
MODELS								
	μ	$.42^{a}$	$.67^{a}$	1.33^{ab}	2.50^{ab}	3.92^{b}	7.08^{bc}	9.17^{c}
	SD	.52	.78	1.49	.67	1.24	3.92	4.74
CONMAPS								
	μ	$.00^{a}$	$.17^{a}$	$.92^{a}$	1.25^{ab}	3.75^{b}	6.92^{c}	7.50^{c}
	SD	.00	.39	1.16	.97	1.86	4.68	3.71
PROBERP								
	μ	$.05^{ab}$	.01	$.08^{ab}$	$.15^{bc}$	$.23^{c}$	$.25^{c}$	$.23^{c}$
	SD	.11	.02	.09	.03	1.07	.07	.09
CAUSERP								
	μ	$.02^{a}$	$.02^{a}$	$.06^{ab}$	$.07^{ab}$	$.13^{bc}$	19^{c}	$.21^{c}$
	SD	.06	.06	.09	.07	.07	.10	.10
PROPERP								
	μ	$.02^{a}$	$.05^{a}$	$.02^{a}$	$.03^{a}$	$.09^{a}$	$.08^{a}$	$.11^{a}$
	SD	.06	.08	.06	.05	.08	.05	.08
PITTGPS								
	μ*	$.25^{a}$	$.33^{a}$	$.58^{a}$	1.00^{a}	2.50^{b}	2.83^{b}	3.50^{b}
	SD	.45	.65	.51	.43	.52	1.12	1.62
PITTHD								
	μ	$.17^{a}$	$.33^{a}$	$.75^{a}$	1.25^{a}	3.33^{b}	3.83^{b}	3.17^{b}
	SD	.39	.49	.75	.75	1.07	1.80	1.52
PITTEVAL								
	μ	$.17^{a}$	$.50^{a}$	$.58^{a}$	2.42^{b}	2.59^{b}	3.25^{b}	3.42^{b}
	SD	.39	.68	.67	.99	.99	.96	1.08
PITTPAT								
	μ	$.17^{a}$	$.50^{a}$	$.50^{a}$	2.25^{bc}	2.08^{b}	3.25^{bc}	3.25^{bc}
	SD	.39	6.7	.67	.86	.99	.75	1.29
PITTFEED								
	μ	$.25^{a}$	$.42^{a}$	$.83^{a}$	2.58^{b}	2.83^{b}	3.42^{b}	3.50^{b}
	SD	.45	.67	.57	.90	1.03	1.31	1.09

*Means with same superscript *do not* differ significantly at .05 level.

Table 2

Correlation Coefficients: All Variables by Level of Participant

Variable	Correlation with PARTLEV
STATE	.6761**
RELPER	.7121**
CONCEPTS	.6701**
CONMAPS	.7390**
MODELS	.7588**
PROPERP	.3863**
PROBERP	.6900**
CAUSERP	.6819**
PITTGPS	.7968**
PITTEVAL	.8087**
PITTFEED	.8020**
PITTHD	.7464**
PITTPAT	.7945**

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

of relevant statements than both groups of high school students [*F* (6,77) = 18.6, p=.05]. In fact, while the results were not statistically significant, it was also interesting to note that the percent of relevant statements used was greater than 90% for the undergraduate majors, graduate students and both groups of Ph.D.'s. Moreover, there was a large difference--nearly seventeen percentage points--in the percentage of relevant statements used by high school economics students relative to high school students who had taken no economics. These results indicated that, for this sample of economic problem solvers, those who had taken high school economics demonstrated quite a large difference in the percentage of relevant statements used relative to those who had not, while those who had taken advanced graduate studies in economics (PHD-FIELD, PHD-UNIVERSITY, GRAD) demonstrated only a marginal increase over their counterpart groups. The data indicated a very strong positive relationship (correlation coefficient =.71; p<.01, See Table 2) between a participant's level of formal economic education and the percentage of relevant statements used to respond to the three economic problems. Thus, for this sample of economic problem solvers, the data indicated that participants with greater levels of expected expertise, as indicated by level of formal economic education, were more likely to use a greater percentage of relevant economic statements in their responses.

Number of Economic Concepts Used (CONCEPTS). The mean number of economic concepts used by respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that the Ph.D. economists (Groups 6 and 7) used a significantly greater number of economic concepts than both groups of high school students and both groups of undergraduate students [F (6,77) = 14.9, p=.05]. Additionally, the graduate students used a significantly greater number of economic concepts than both groups of high school students. However, while the number of concepts used by graduate students was significantly greater than both groups of high school students, no significant difference was found between the number of concepts used by graduate students and the number used by undergraduate majors and non-majors, or between the two high school groups.

Again, while the results were not all statistically significant, it is important to note that the graduate students, university-Ph.D.'s and field based-Ph.D.'s used nearly three, four and five times the number of economic concepts respectively than did the two undergraduate groups. Further, there was extremely little difference between the number of concepts used by both undergraduate majors and non-majors and marginal differences between the two high school groups. These data suggested that those who had graduate training (GRAD), and advanced graduate training in economics (PHD-FIELD, PHD-OSU) demonstrated a much greater use of economic concepts relative to the other four groups, while those who had taken high school and undergraduate economics demonstrated little or no difference in the number of concepts used over counterpart sub-sample groups. These data also indicated a substantial positive relationship (correlation coefficient =.67; p<.01, See Table 2) between a participant's level of expected expertise, as indicated by formal economic education and experience, and the number of economic concepts used in response to the three economic problems.

Number of Concept Maps Used (CONMAPS). The mean number of economic concept maps used by respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance suggested that the Ph.D. economists (Groups 6 and 7) used a significantly greater number of economic concept maps than both groups of high school students, both groups of undergraduate students, and the graduate students in economics [F (6,77) = 20.4, p=.05]. In addition, the graduate students used a significantly greater number of economic concept maps than both groups of high school students. However, while the number of concept maps used by graduate students was significantly greater than both groups of high school students, no significant difference was found between the number of concepts maps used by graduate students and undergraduate majors and non-majors or between the two high school groups.

In fact, while not all of the results were statistically significant, it was noteworthy that both Ph.D. groups used approximately twice the number of concept maps as the graduate students. Moreover, the high school economics students and the undergraduate majors in economics used only marginally greater numbers of concept maps than counterpart groups, while the graduate students used exactly three times the number of concept maps used by the undergraduate majors. These results suggested that, for this sample of economic problem solvers, those who had graduate, and advanced graduate, training in economics demonstrated greater usage of economic concept maps. Conversely, those who had high school or undergraduate economics demonstrated only a marginally greater use of economic concept maps over their respective counterpart groups. These data indicated a very strong positive relationship (correlation coefficient = .73; $p < .01$, See Table 2) between a participant's level of formal economic education and experience and the number of economic concept maps used in response to the three economic problems.

Number of Economic Models Used (MODELS). The mean number of economic models used by respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that the Ph.D. economists (Groups 6 and 7) used a significantly greater number of economic models than both groups of high school students and both groups of undergraduate students, and that the university Ph.D.'s used significantly more economic models than the graduate students in economics [$F\ (6,77) = 22.3$, $p<.05$]. In addition, the graduate students used a significantly greater number of economic models than both groups of high school students. While the number of concept maps used by graduate students was significantly greater than both groups of high school students, no significant difference was found among number of concepts used by graduate students and those used by undergraduate majors and non-majors in economics or between the two high school groups.

Again, while not all statistically significant, these results are of some practical significance. It is particularlyinteresting to note that the university-Ph.D.'s and field based-Ph.D.'s invoked nearly two and three times, respectively, more economic models during responses than did the graduate students in economics. Further, it is important to stress that, once again, those who had participated in high school economics demonstrated only very small differences over the counterpart group. However, for this sample of economic problem solvers, undergraduate economics majors used nearly twice as many economics models as did undergraduate non-majors. These results suggested that those with undergraduate, graduate and advanced graduate training in economics employed a significantly greater number of economic models. Moreover, those with training in high school economics displayed very little difference in the number of models used relative to the counterpart sub-sample group. These data also indicated a very strong positive relationship (correlation coefficient = .76; $p<.01$, See Table 2) between a participant's level of expected expertise, as indicated by formal economic education and experience, and the number of economic models used in response to the three economic problems.

Problem Representation Expert Ratio Profile (PROBERP). The problem representation ERP was calculated by dividing the number of statements used by the respondent to reorder, reclassify or subdivide the problem by the total number of relevant statements used. Thus, this ERP was a ratio of problem representation statements used to total relevant statements used. The mean problem representation ERP of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance implied that the Ph.D. economists (Groups 6 and 7), the graduate students (Group 5) and the undergraduate majors in economics (Group 4) had significantly higher problem representation ERP's than both high school groups and the undergraduate non-majors [$F\ (6,77) = 16.2$, $p<.05$]. Similarly, the graduate students in economics had significantly higher problem representation ERP's than did the undergraduate non-majors and both high school groups.

While not all statistically significant, these results are nonetheless interesting. For example, the graduate students and both Ph.D. sub-groups used nearly the same percentage of problem representation statements. This level was twice the percentage used by undergraduate economics students and nearly three times the percentage used by the other undergraduate group. Curiously, the high school students without economic training used a greater percentage of problem representation statements than the high school economics students. These findings suggested that the use of problem representation in problem solving, for this sample of economic problem solvers, is more closely associated with the experience of graduate and advanced graduate training in economics. However, the participants who experienced undergraduate training also demonstrated relatively frequent use of problem representation statements. The researcher was unable to develop a cogent argument for the relatively low levels of problem representation demonstrated by Group 2, although one supposition might involve a kind of "fishing around" scenario. That is, as one achieves a certain level of expertise, it may be the case that attendant levels of problem representation decrease at the margin--experts focus on the problem and narrow it down immediately. Those with less expertise may be forced to cast and re-cast a problem while searching for the problem's significant elements, and thus use more PROBERP than expert counter-parts.

These data indicated a substantial positive relationship (correlation coefficient = .68; $p<.01$, See Table 2) between a participant's level of expected expertise, as indicated by formal economic education and experience, and the ratio of problem representation statements to total statements used.

Causal Statement ERP (CAUSERP). The causal statement ERP was calculated by dividing the number of causal statements--those that resembled an 'A causes B' model--used by the respondent by the total number of relevant statements used. Thus, this ERP was a ratio of causal statements to total relevant statements. The mean causal statement ERP of respondents, according to level of formal economic education and experience, is presented in Table 1. The data indicated differences in each of the seven sub-sample groups' causal statement ERP. A one-way analysis of variance suggested that the Ph.D. economists (Groups 6 and 7), had significantly higher causal ERP's than both high school groups and both undergraduate groups [F (6,77) = 12.2, $p<.05$], and the graduate students in economics had significantly higher causal ERP's than did both high school groups. In fact, in absolute terms, no difference existed in the percentage of causal statements used by both high school groups. Additionally, the undergraduate economics majors used only marginally greater percentages of causal statements. Conversely, the Ph.D. groups used tremendously greater percentages of casual statements than did both high school groups and both undergraduate groups, and nearly seventy-five percent more than the graduate students.

These data also suggested a substantial positive relationship (correlatioı coefficient = .69; $p<.01$, See Table 2) between a participant's level of formal economic education and experience and the ratio of causal statements to total statements used.

Propositional Statement ERP (PROPERP). The propositional statement ERP was calculated by dividing the number of statements that resembled an 'if....then' model by the total number of relevant statements used. Thus, this ERP was a ratio of propositional statements to total relevant statements. The mean propositional statement ERP of respondents, according to level of formal economic education is presented at Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 3.3, p<.05].

Though the ANOVA indicated no significant differences in the percentage of propositional statements used, some commentary on these results is still warranted. For this variable, the high school economics students used nearly three times the percentage of propositional statements as did the counterpart group. Similarly, the undergraduate majors used nearly twice the percentage of propositional statements as did the undergraduate non-majors. Finally, the graduate students and both Ph.D. groups used nearly three times the percentage of causal statements of the undergraduate majors. These data also indicated a moderate positive relationship (correlation coefficient = .39; p<.01, See Table 2) between a participant's level of formal economic education and experience and the ratio of propositional statements to total statements used.

Figure 3 represents a graphical comparison of the first four variables described above: STATE, CONCEPTS, CONMAPS, and MODELS. Figure 4 represents a graphical comparison of the variables RELPER, PROBERP, PROPERP and CAUSERP.

It was evident from both Figure 3 and Figure 4 that the level of most of these eight relevant indictors of expertise in economic problem solving increased across level of economic education (PARTLEV). Indeed, this trend appeared to hold for each of the eight variables under consideration. However, in several cases (e.g., STATE, CONCEPTS) it was also evident that the pattern noted above did not always hold.

A second important point to be gleaned from Figures 3 and 4 involve the size of increase in the levels of the eight variables across various levels of economic education. Indeed, the increase in the level of the eight variables across level of economic education was neither uniform nor, in most cases, continuous. These results will be discussed further in subsequent analysis in this report, but suffice to say, Figures 3

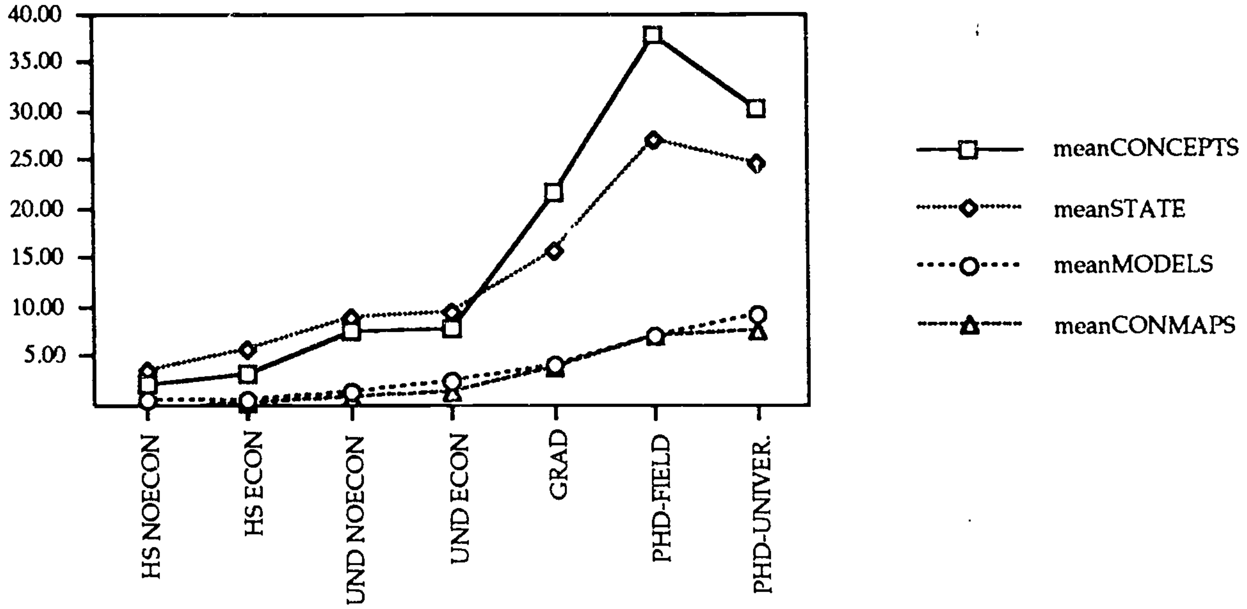

Figure 3. Comparison of Summary Statistics: STATE, CONCEPTS, CONMAPS, MODELS

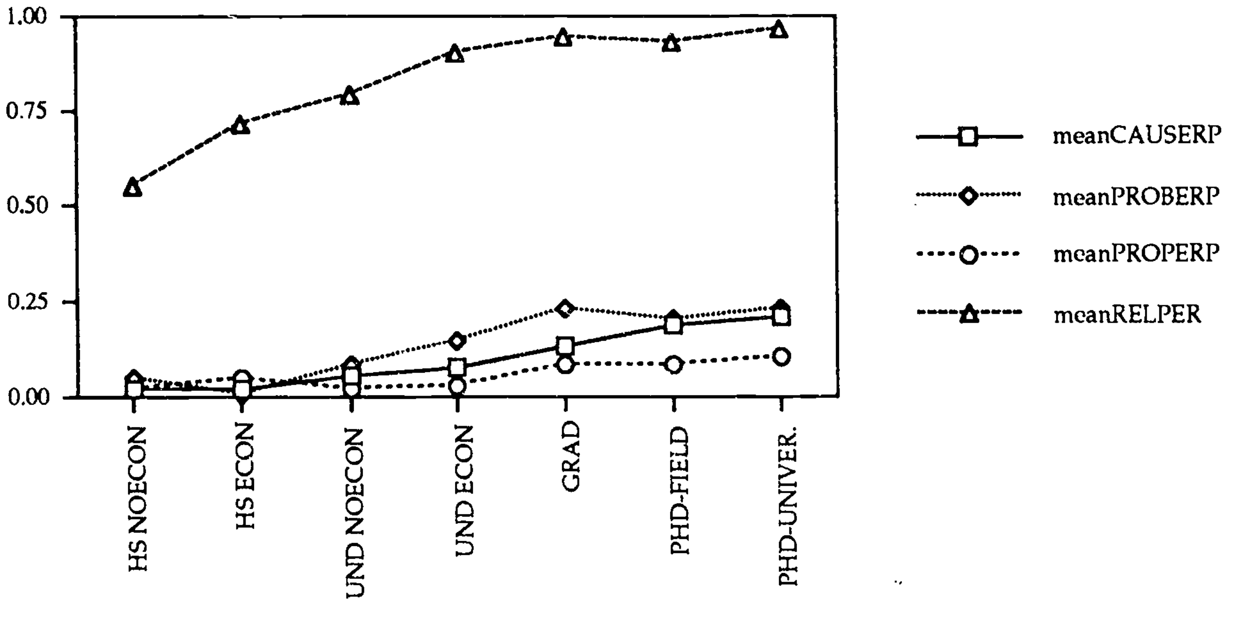

Figure 4. Comparison of Summary Statistics: RELPER, PROBERP, PROPERP, CAUSERP

and 4 offer evidence that, for this group of problem solvers and for this set of variables, the acquisition of expertise in economic problem solving was not a continuous phenomenon with equi-distant categories.

The Pitt Problem Solving Coding System (PPSCS)Variables

As noted earlier, the PPSCS provided "a comprehensive, empirical instrument to code heterogeneous verbal protocols in terms of the type of processing function each verbal proposition represents" (Pitt, p. 551). In addition, the PPSCS provided a reasonable method for classifying verbal responses along a commonly accepted problem solving model. Specifically, use of the PPSCS helped present a more detailed picture of the general economic problem solving abilities and strategies of the respondents.

PPSCS: General Problem Solving (PITTGPS). The general problem solving measure was generated by counting the number of statements coded as meeting the Pitt GPS criteria. The mean GPS of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 28.8, $p<.05$] among Groups 1-4. Additionally, the ANOVA indicated that Groups 5-7 did not differ significantly. However, Groups 5-7 did differ significantly from Groups 1-4.

These data indicated that the graduate students, and both Ph.D. groups, used significantly more Pitt GPS statements than both high school groups and both undergraduate groups. The high school economics students used only a marginally greater number of Pitt GPS statements than the counterpart group, while the graduate students used two and one-half times more Pitt GPS statements than undergraduate majors. The university-Ph.D. group used three and one-half times more GPS statements than the graduate students and a marginally greater number than the field-based Ph.D.'s. These data also suggested a very strong, positive relationship between Pitt GPS statements used and formal level of economic education (correlation coefficient = .80, $p < .01$; See Table 2).

PPSCS: Hypthetico-deductive. (PITTHD) The Pitt hypothetico-deductive (HD) measure was generated by counting the number of statements coded as meeting the Pitt HD criteria. The mean HD of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 28.8, $p<.05$] among Groups 1-4.

Additionally, the ANOVA indicated that Groups 5-7 did not differ significantly in the number of Pitt HD statements used. However, Groups 5-7 did differ significantly from Groups 1-4.

Moreover, these data suggested that those participants who had experienced high school economics used twice the number of Pitt hypothetico-deductive statements as the counter part group. Despite this, the absolute difference in the mean number of Pitt HD statements used by both high school groups and the undergraduate non-economics majors was so small as to be relatively insignificant. Indeed, even the undergraduate majors used an average of only slightly more than one Pitt HD statement per response. However, both groups of Ph.D.'s, and the graduate students,used approximately three times the number of Pitt HD statements as the undergraduate majors.

PPSCS: Pattern Extraction (PITTPAT). The Pitt pattern extraction measure was generated by counting the number of statements coded as meeting the Pitt PAT criteria. The mean PAT of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 29.18, $p<.05$] among Groups 1-3 or between Groups 4 and 5. Additionally, the ANOVA indicated that Groups 4 and Groups 6 and 7 did not differ significantly in the number of Pitt PAT statements used. However, Groups 4 and 5 did differ significantly from Groups 1-3, and Groups 6 and 7 differed significantly from Groups 1-3 and from Group 5.

More importantly, however, these data suggested that those participants who had experienced high school economics used three times the number of Pitt extraction statements as participants who had not experienced high school economics. Interestingly, the mean number of Pitt pattern extraction statements used by high school economics students and the undergraduate non-economics majors was equivalent. Even more surprising was the fact that while the undergraduate majors used nearly five times the number of Pitt pattern extraction statements as the undergraduate non-majors, the graduate students used slightly fewer pattern extraction statements, on the average, than the undergraduate majors. Finally, both groups of Ph.D. economists used the same mean number of pattern extraction statements. This mean represented a fifty percent increase in pattern extraction statements over the undergraduate majors, and a seventy-five percent increase over the graduate students.

PPSCS: Feedback (PITTFEED). The Pitt feedback (FEED) measure was generated by counting the number of statements coded as meeting the Pitt FEED criteria. The mean number of feedback statements of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 29.71, p<.05] among Groups 1-3. Additionally, the ANOVA indicated that Groups 4-7 did not differ significantly in the number of Pitt FEED statements used but Groups 4-7 did differ significantly from Groups 1-3.

These data indicated that while the expected pattern of increasingly greater usage of PITTFEED statements held for the sample groups, a substantial difference existed in this pattern of usage between Groups 1-3 and Groups 4-7. That is, the undergraduate economics majors (and groups above) used a much greater number of PITTFEED statements than any of the first three groups. The groups above the undergraduates majors used more PITTFEED statements, but only marginally so. Thus, the data suggested that participants who had experienced undergraduate economic training--and those with economic training beyond--"leaped" ahead of the previous three groups with respect to PITTFEED usage.

PPSCS: Evaluation (PITTEVAL). The Pitt evaluation measure was generated by counting the number of statements coded as meeting the Pitt evaluation statement criteria. The mean number of evaluation statements of respondents, according to level of formal economic education and experience, is presented in Table 1. A one-way analysis of variance indicated that these differences were not significant [F (6,77) = 31.39, p<.05] among Groups 1-3. Additionally, the ANOVA indicated that Groups 4-7 did not differ significantly in the number of PITTEVAL statements used. However, Groups 4-7 did differ significantly from Groups 1-3.

Again, while not all the differences among the mean number of evaluation statements made were statistically significant, some interesting patterns continued to emerge. As with each of the other Pitt Problem Solving variables, participant's usage of PITTEVAL statements followed the expected pattern of increasingly greater usage as the level of formal economic education and experience of participants increased. More importantly, however, the data regarding the number of PITTEVAL statements used confirmed the presence of a second pattern. This pattern involved a "leap"--a significant increase in level of usage of a Pitt variable over previous groups--of qualitatively different proportions. That is, at some level of economic expertise, participants demonstrated a substantially greater usage of the Pitt Problem Solving attributes than had groups with less economic education. For three of the Pitt variables (PITTEVAL, PITTFEED, and PITTPAT), this "leap" was manifest in the undergraduate economic majors. For the remaining Pitt variables (PITTHD and PITTGPS), this "leap" was evident from the graduate students. What these results imply is that, for aspects of problem solving measured by the PPSCS, a clear pattern concerning the acquisition of expertise in economic problem solving emerged. Indeed, the data suggested that, at least for this small sample of economic problem solvers, certain attributes of formal training in economics led to a substantial rise in the level of usage of PPSCS variables.

Figure 5 represents a graphical comparison of the sub-group means for each of the Pitt variables described above and provides evidence that the pattern noted for the first eight variables continued to hold.

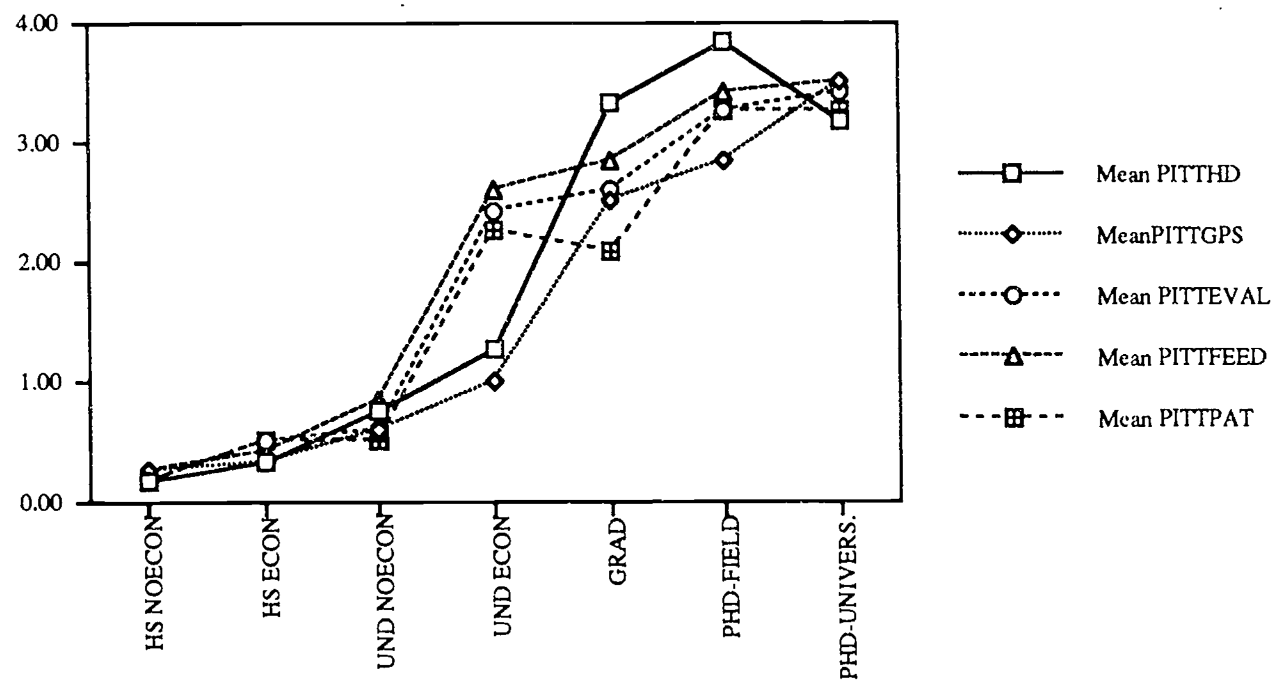

Figure 5. Comparison of the Mean Levels of the PPSCS Variables

That is, the levels of PPSCS variable demonstrated increased across level of economic education. What was even more interesting, for these PPSCS variables, was the significant change in the level of all PPSCS variables associated with either undergraduate or graduate training in economics. In fact, it should be noted that Figure 5 also seemed to indicate the presence of a "leap" in level of expert-like problem solving--for this sample of problem solvers--at some point along the path to expertise and thus provided further evidence for the apparent discontinuuity of expertise acquisition for this small sample.

Standardized Rank Data

The last set of results for this study involved data concerning the absolute rankings of participant responses across each of the variables under investigation. Using SPSS to re-configure the raw data set for each variable, a new series of variables was created: mean absolute ranking of respondents by participation level. By comparing the ranking of all participant responses relative to the position of other respondents (and resolving all ties with the mean position of the tied responses), this analysis provided further insight into the nature and constructs of relative expertise by allowing the calculation of a series of mean rankings for each variable across participant level (PARTLEV). With these mean rankings (calculated on the range 1-84), it was possible to examine the position of each sub-sample group--across each variable--relative to the other sub-sample groups. A comparison of these mean rankings may be seen in Figure 6 and Figure 7. It should be noted that, across most of the variables studied, the mean rankings corresponded well with participant's level of economic education. In fact, a correlation analysis of the relationship between the mean rankings and participant's level of formal economic education ranged from moderate to very strong. Table 4 reports these correlation coefficients. These results suggested that, at least for this sample of economic problem solvers, the initial supposition that the level of participant's formal economic education was related to expected levels of expertise was accurate. Indeed, the mean ranking data confirmed that, across each of the variables, respondents' performance on each variable tended to rank according to their level of economic education.

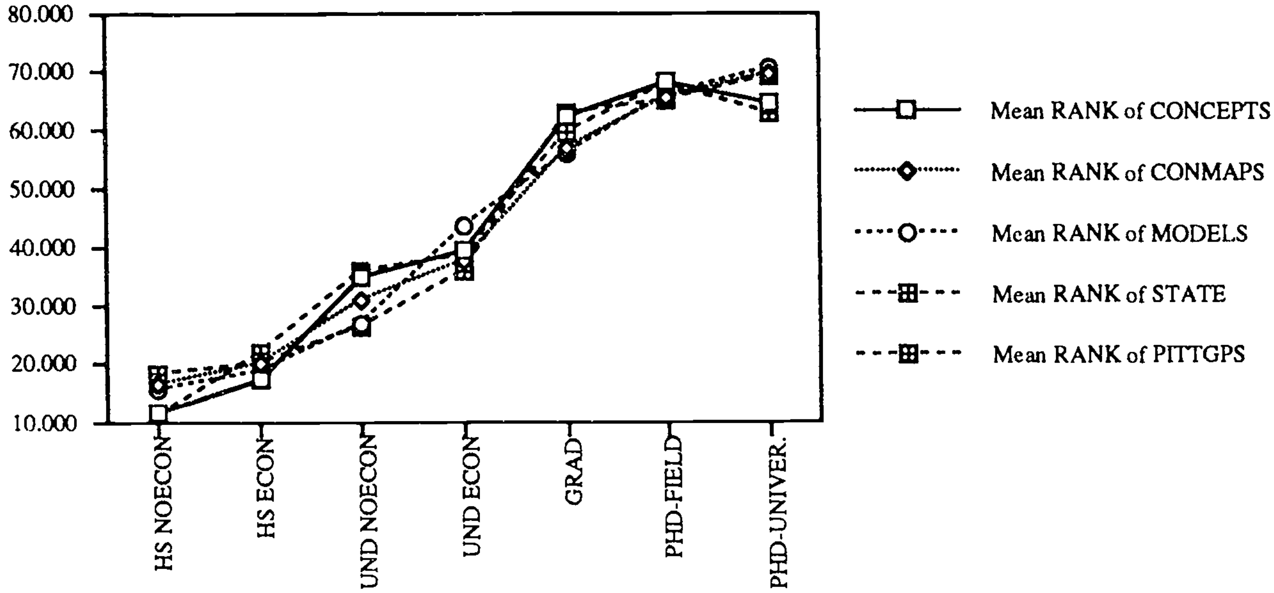

Figure 6. Comparison of Mean Standardized Rankings of CONCEPTS, CONMAPS, MODELS, STATE and PITTGPS

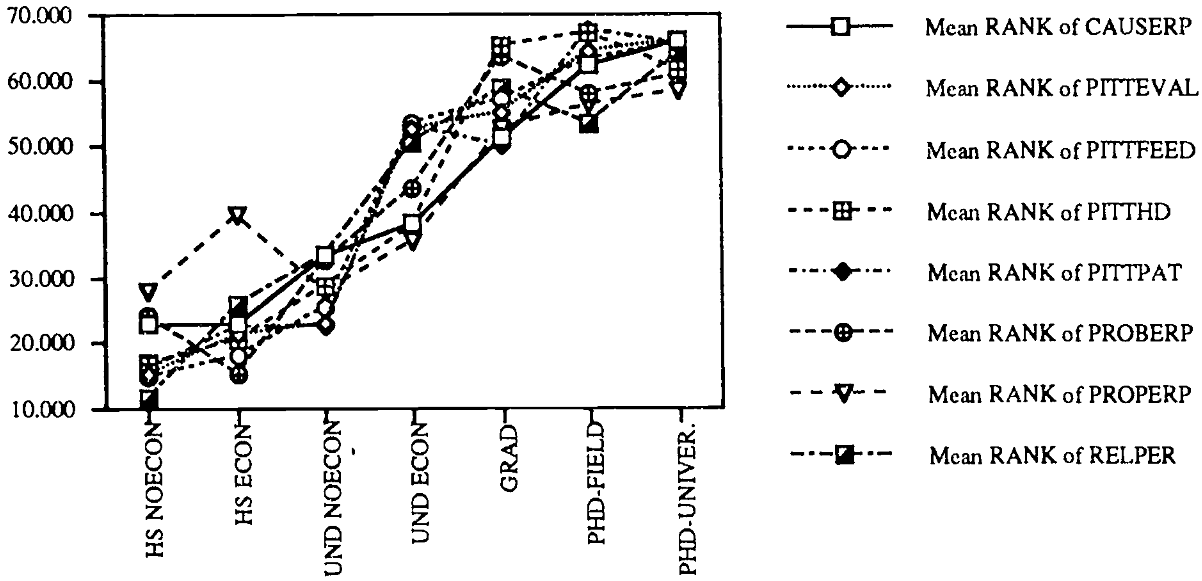

Figure 7. Comparison of the Mean Standardized Rankings of CAUSERP, PITTEVAL, PITTFEED, PITTHD and PITTPAT

Table 4

Correlation Coefficients for Mean Standardized Rankings of All Variables with Level of Participants

IRankIVariable	Coefficient
RMODELS	.8570**
RCONCEPT	.8474**
RPITTGPS	.8376**
RCONMAPS	.8369**
RPITTFEE	.8217**
RPITTEVA	.8174**
RPITTPAT	.8062**
RPITTHD	.7998**
RSTATE	.7937**
RRELPER	.7061**
RCAUSERP	.6984**
RPROBERP	.6780**
RPROPERP	.4803**

* - Signif. LE .05   ** - Signif. LE .01   (2-tailed)

However, it was also interesting to note the exceptions to these trends. For example, the mean rankings of the graduate student's problem representation ERP were above both Ph.D. groups. Similarly, the high school students with no economics ranked above the high economics students on the problem representation ERP (see Figure 7). As noted earlier, it may very well be the case that these results were due to some kind of "fishing around" on the part of respondents. As noted earlier, it may be the case that attendant levels of problem representation decrease at the margin. Thus, those with greater levels of expertise may be able to a problem with respect to sub-problem identification, while those with less expertise must continually re-cast a problem while searching for the problem's significant elements.

However, these exceptions, in conjunction with the data concerning the mean rankings, seemed to refute the supposition that the path to expertise was a continuum, with equi-distant categories along it. Indeed, although it was true that the order of the mean rankings for respondents was relatively consistent with intuitive expectations based upon participant's level of formal economic education, the intervals in these mean rankings were by no means equally distributed across each variable. These results suggested that the process of moving from one category of expertise to another was not the same across all sub-group categories. Certainly this was evident in the fact that, for several sub-groups, the calculated mean ranking on certain variables was above or below generally expected levels. The case of the problem representation statements noted above was one such example. Other examples included the mean rankings of number of relevant statements used, the mean rankings of propositional statements made and the mean rankings of the number of Pitt evaluation statements made (See Figure 7). Moreover, if the path to expertise were continuous, the movement along such a continuum would imply intervals. The data suggested that, for the variables noted above, this was not the case.

Finally, as the data were standardized by rank, it was possible to calculate a mean of the mean rankings across all variables (Table 4). The results of this analysis suggested that the intervals between mean rankings were not equi-distant relative to each other. Indeed, it was apparent that the mean rankings fell into three groupings with respect to the standardized data: the two high school groups, the two undergraduate groups and the graduate students and both Ph.D. groups.

Table 4

Mean of the Mean Standardized Rankings (1-84) for All V riables

Level of Participant	MEAN OF MEAN RANK
1	16.31
2	22.11
3	30.78
4	37.95
5	59.75
6	63.58
7	64.39

The ranked data were further analyzed across all thirteen variables using hierarchical cluster analysis to determine if underlying groupings were present. The cluster analysis technique compared the similarity or distance associated with a group of cases and classified like variables into groups, or clusters, based on likeness. The results of this cluster analysis revealed that the mean cluster level (based on degree of association relative to all other groups) for both groups of high school students was 1.04. This implied that a first cluster was created around the first twenty-four rankings. In other words, all but two of the first twenty-four cases were assigned to the first cluster--a very high degree of similarity.

The analysis grouped both undergraduate sub-groups into a second cluster and the mean cluster level for both groups was 1.74. This implied that a cluster--but perhaps not as tight a cluster as for the first twenty-four--was created around the second twenty-four rankings. Indeed, nineteen out of these twenty-four cases were assigned to the second cluster. For the graduate students and both Ph.D. groups, the mean cluster level was 2.94. This implied that a third cluster was created around the last thirty-six rankings. These results suggested that the three groupings outlined in the previous mean ranking analysis were plausible. What these results also seemd to confirm was the presence of a categorization of expertise beyond the simple expert/novice construct; namely a category of *relative* expertise in economic problem solving.

Figure 8 represents a graphical depiction of the mean rankings across participant levels and these results suggested two important conclusions. First, it was evident from Figure 8 that, to some extent, the "leap" concept introduced earlier in this analysis was also present in this data. In fact, one should note the

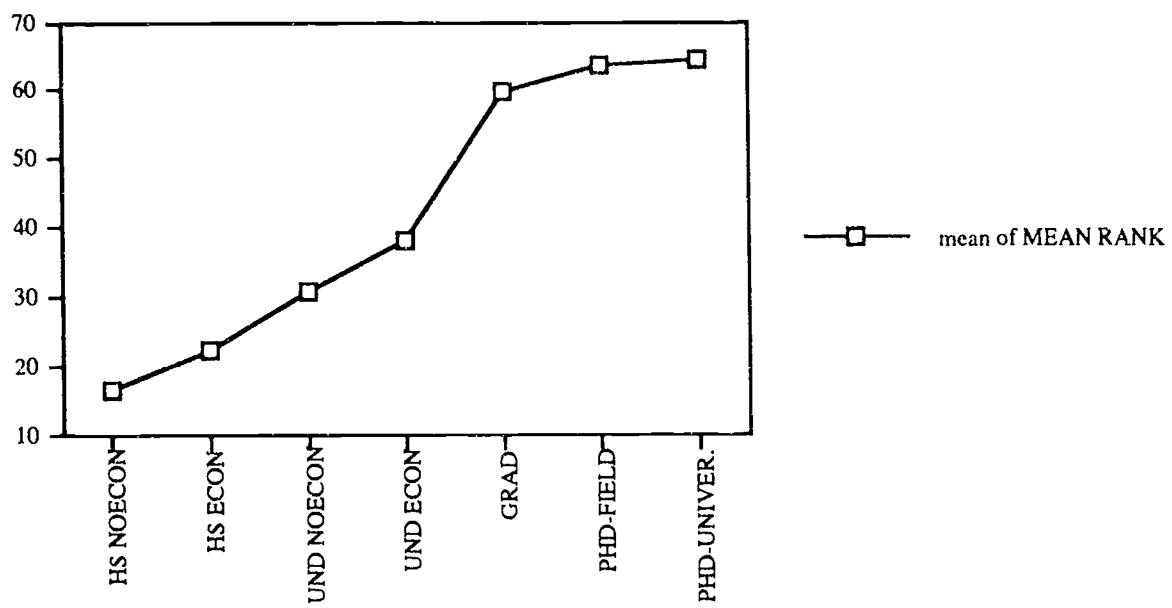

Figure 8. Comparison of the Means of Standardized Mean Rankings for All Variables Across Level of Participant

obvious change in slope associated with movement from undergraduate major to graduate student. Similarly, there was also a certain flattening in the mean rankings associated with movement from graduate student to both level of Ph.D.'s. These results seemed to confirm suppositions made earlier in this report concerning the nature of expertise and its acquisition. Namely, that the path to expertise, at least for this small sample of economic problem solvers, was not continuous and that, at the margin, certain levels of economic education appeared to exhibit diminishing returns with respect to increased acquisition of expertise in economic problem solving.

Conclusions

The current study has been an attempt to learn more about expertise in economic problem solving and the nature of relative expertise. Given the plethora of data, and the analytical techniques brought to bear upon them, it would be nice to draw some clear-cut conclusions about problem solving in economics. This, however, is not the case. Based upon the litany of limitations and assumptions associated with the study, one should only seek to draw the most guarded and tentative conclusions. The reader is also reminded that the application of many of the analytical techniques used in the current study was done to more accurately describe the sample in question and should not be generalized to larger populations without careful consideration and critique.

Having stated these caveats then, what follows is a brief list of the outcomes of this study.

1. Indications of a very strong, positive relationship between each of the thirteen variables and the level of expected expertise in economic problem solving as indicated by participant level.
2. Identification of mostly marginal differences in the observed mean levels the thirteen variables, indentified as indicators of expertise, for the high school economics students over those who had not taken high school economics. A similar pattern was present in the observed mean levels of variables for both Ph.D. groups over the graduate students. Finally, the data indicated that some significant differences did exist between undergraduate economics students and their non-major counterparts.
3. Identification of a pattern in the observed level of Pitt Problem Solving variables across levels of expected expertise. This pattern involved a "leap"--or a significant increase in usage of Pitt variables over previous groups--of qualitatively different proportions. At certain levels of expected economic expertise, participants demonstrated a substantially greater usage of the Pitt Problem Solving attributes than had groups with less expected economic expertise.

4. Support for the pattern noted above in the results of the mean standardized ranking analysis. Indeed, a hierarchical cluster analysis suggested that the rankings grouped into three clusters: (a) both high school groups; (b) both undergraduate groups; and (c) the graduate students and both Ph.D. groups.

5. Support for the hypothesis that the path to expertise was not a continuum with equi-distant categories along it. This support lay in results from both the mean ranking analysis and the analysis of percentage change in observed levels of the variables across the categorical levels of participants.

Beyond these guarded conclusions, there are some other highly speculative, yet intriguing possibilities along the path to achieving economic expertise. The focus in economic education has been on the teaching of economic concepts. The findings in this study show no differences of practical or statistical significance between either of the high school groups, nor between the two groups of college students. Moreover, the college students who had no formal economics courses, high school or college, invoked concepts in their responses more than twice as often as the high school students who had taken economics.

One possible conclusion is that the teaching of economic concepts has made little difference in the learning of these students. Alternatively, and the researchers think more likely, the students who have had formal economics instruction have little increased ability to use the concepts they have learned in responding to economic problems. The performance of Group 3 (UND-NOECON) suggests that they achieved their modest level of conceptual learning without the benefit of an economics course. But, they were as able to display what economic concepts they had acquired (presumably from life experiences), better than high school students and equally as well as there college counterparts. This might be interpreted as evidence for growth in their economics schema -- the bits of economic knowledge are more connected and accessible, and therefore more useful in solving problems.

When looking for evidence of other dimensions of expertise beyond declarative knowledge, the data suggest two especially significant points in the path to expertise. Despite the lack of difference between the college students on the concept variable, there are marked difference of practical significance on three of the Pitt variables (which were also statistically significant) and their use of economic models. One possible interpretation of these results supports the speculation above -- that college economics begins to produce some integration of the knowledge students have into a more unified whole.

Perhaps this phenomenon is best seen in the MODELS variable, one of particular significance in economics since the discipline relies so heavily on the development and use of models. The undergraduate economics students in this study used models in their responses three and one-half times as often as the high school economics students, and nearly twice as often as their undergraduate counterparts who had no economics. The graduate students invoked models more than the undergraduates, and the university professors employed models more than twice as often as the graduate students. One might speculate that models are the basic integrating structure of the discipline and that their use is a significant characteristic of a developing economics schema.

The second point, which has been mentioned already, is study of graduate level economics. As noted above, this emerges most clearly in Figure 8 comparing the means of the standardized mean rankings. This figure summarizes the results across all variables and points strongly to a sizable change in the expertise in economics of the members in this group, at least in this sample.

It is unreasonable to expect economic educators to provide graduate level understanding to high school students. If economics problem solving is the real goal of economic education, however, then perhaps by focusing more clearly on other dimensions of expertise in high school economics, and by a clearer understanding of what distinguishes relative expertise, economic educators can help high school students become more adept economic problem solvers.

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Appendix A:

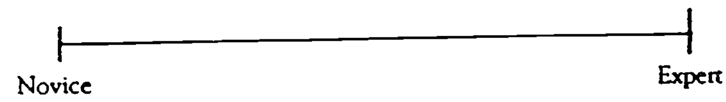
Relevant Indicators of Expertise in Economic Problem Solving (Variables Investigated)

STATE	Absolute Number of Relevant Statements Made
RELPER	Percentage of Relevant Statements
CONCEPTS	Number of Economic Concepts Used
MODELS	Number of Economic Models Used
CONMAPS	Number of Concept Maps Used
PROBERP	Problem Representation Statement to Absolute Statement Ratio
PROPERP	Propositional Statement to Absolute Statement Ratio
CAUSERP	Causal Statement to Absolute Statement Ratio
PITTGPS	Pitt Coding Variable: General Problem Solving
PITTHD	Pitt Coding Variable: Hypothetico-deductive statements used
PITTFEED	Pitt Coding Variable: Feedback statments used
PITTPAT	Pitt Coding Variable: Pattern extraction statements used
PITTEVAL	Pitt Coding Variable: Evaluation statements used

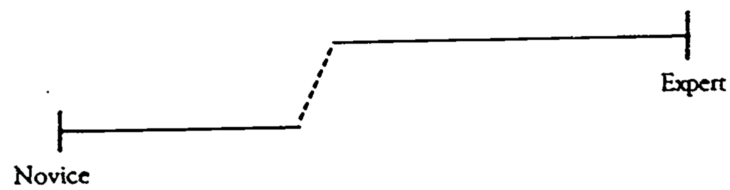
APPENDIX B

HYPOTHETICAL MODELS OF THE ACQUISTION OF EXPERTISE IN ECONOMIC PROBLEM SOLVING

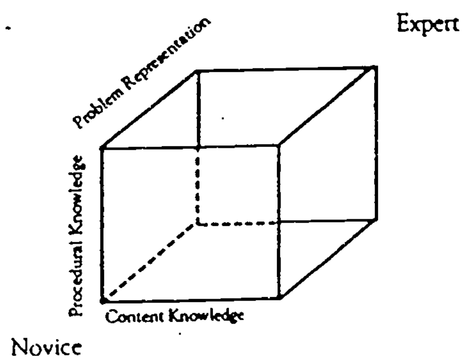
1. Continuum



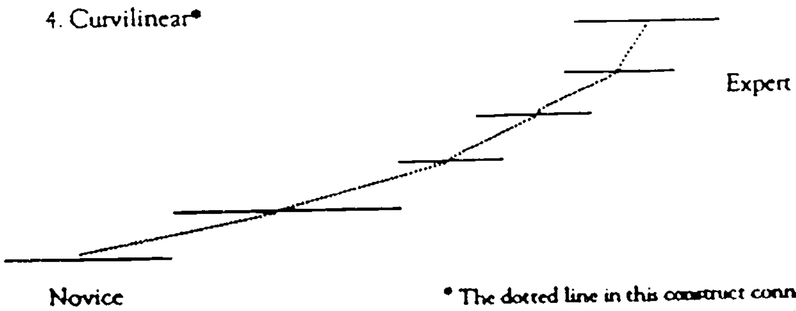
2. Discontinuous Continuum



3. Multiple Continua



4. Curvilinear*



* The dotted line in this construct connects the means of a range of scores, or other indicators, associated with a sub-sample of the study and represents one hypothetical "shape" of expertise.

APPENDIX C

STANDARDIZED PARTICIPANT DIRECTION SHEET FOR 'TALK-ALOUD' PROTOCOLS

Directions for Economic Problems Exercise

In a moment, you will be given the first of three economic problems. Once you have the problem sheet in front of you, please note the following directions:

1. you will have **one minute** to familiarize yourself with the problem

2. at the end of this time, please begin to discuss the problem:
   - speak clearly
   - be as detailed as you are able
   - take as long as is necessary to discuss the problem thoroughly

3. feel free to write or draw on the blank paper below the problem

4. you may ask for general assistance, but the interviewer cannot suggest solutions, etc. to the problem

If you are confused in any way as to what these directions instruct you to do, please ask at this time. This procedure will be repeated for each of the three problems.

APPENDIX D

EXAMPLES OF ECONOMIC CONCEPTS USED IN RESPONSES

Economic Concepts Used by Respondents

supply and demand
equilibrium price
market clearing price
unemployment
labor supply
labor supply curve
quantity of labor adjustment
wage bill
efficiency
net value
assets
economic price
price
markets
deflation
inflation
money supply
budget deficit
the Federal Reserve system
full employment
fiscal policy
competition
producers
consumers
price levels
subsidies
exports
dumping
externalities
anti-trust
trade barriers
scale economies
interventionist
comparative advantage
human capital
real wage rates
minimum wage
wage floor
investment expenditures
aggregate demand
aggregate supply
fiscal policy
monetary policy
taxation

fixed exchange rates
flexible exchange rates
currency
real value of the dollar
short-run
long-run
distribution of income
Gini co-efficient
tariffs
quotas
business
cycle
elasticity of demand
speculation
nominal interest rates
real interest rates
contractionary policy
expansionary policy
trade balance
industrial policy
opportunity costs
productivity
marginal productivity
capital
free trade

APPENDIX E

LIST OF ECONOMIC MODELS USED BY RESPONDENTS

Examples of Economic Models Used by Respondents

labor market model
capital market model
exchange rate model
Keynesian AD model
Industrial organization/policy model
public choice model
monetarist model
general market model
IS-LM model
micro price theory model
long-run growth model