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ABSTRACT

This study explores the nature of professional expertise in economics. Two experiments were conducted to examine the existence of problem categories in economics as a basis for problem representation. Findings are that experts use categories that reflect major economics principles, and novices sort by literal cues contained in the problems. In the second trial, experts did not produce stable sortings whereas novices produced a stable sorting of categories. Subjects included 6 experts, 6 intermediate fourth-year university students in economics, and 6 novices in the first year of college with one semester in economics. Subjects were asked to sort 18 economics problems into groups based on similarities of solution. After sorting the problems, subjects were asked to write down the problem-numbers and give a description of the category. A second study was to determine the stability of sorting procedures among experts after a lapse of six weeks. No differences were found in the average number of categories produced per sort between different groups. (EH)

Expert novice differences in the representation of economics problems

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Abstract

The nature of professional expertise in social sciences and economics appears to differ markedly from mathematics and science. In mathematics and science many problems have a single representation and one solution mutually agreed upon by experts. However, agreement, if any, among experts in economics seems limited. The present study explores the nature of professional expertise in economics. Two experiments were conducted to examine the existence of problem categories in economics as a basis for problem representation. It was found that experts use categories that reflect major economics principles, and novices sort by literal cues contained in the problems. However, experts did not produce stable sortings at the second trial. Novices produced a stable resorting.

Introduction

In recent years, a number of investigations have been done on the question how experts and novices differ in problem-solving in general (e.g. Chase & Simon, 1973), or in particular subject matter domains like physics, mathematics and medicine (e.g. Chi, Feltovitch & Glaser, 1981; Berger & Wilde, 1987; Schmidt, Norman & Boshuizen, 1990). Studies of expert-novice differences in science (e.g. physics and mathematics) problem-solving show that experts not only possess substantially more information than novices, but also solve problems much more quickly than novices. It seems that experts are more efficient at searching a particular solution or finding a correct diagnosis (Ericson & Smith, 1991). There are also differences in the representation of problems. Novices tend to organize their representation around the surface structure of the problems. Knowledge of novices is organized around literal objects explicitly given in a problem statement. This is in sharp contrast with experts' knowledge. This knowledge is organized around principles and abstractions that subsume these objects. Principles that are not explicitly stated in a problem, or are only implied by problem statements . It is generally assumed that the relation between the structure of the knowledge base and problem-solving process is mediated through the quality of the representation of the problem (Glaser, 1984). For example, physics experts represent physics problems in abstract terms like point-masses or massless strings, whereas novices often use naive concepts, such as blocks, ropes and slopes. These naive concepts are often direct observations based on common sense, resulting in misconceptions about physics (Anzai, 1991).

The study conducted by Chi, Feltovitch and Glaser (1981) is a case in point. These researchers focused, in their study of experts on physics, on the initial encoding of physics problems to account for expert novice differences. They asked experts and novices to sort a large number of problems into categories of similar problems. It was assumed that experts' encoding would incorporate information about solution methods.

They found that categories of problems reflected the physical principles underlying the problems, whereas the novices' categories were based on the situations and objects mentioned in the problem text. It was also found that resorting the same stack of problems by experts and novices resulted in a stable sort within two trials.

Problem solving in social sciences and economics appears to differ markedly from problem solving in mathematics and science. In mathematics and science many problems have a single representation and one solution mutually agreed upon by experts. These representations are based on fundamental laws and principles. However, in the domain of social sciences, only limited agreement may exist, if any, among experts about underlying principles, mechanisms or laws. This holds even true for the science of economics, having developed the greatest level of sophisticated abstract theories. However, economists may not only disagree about the solution of a problem, but also about the factors held responsible for certain phenomena in real life economics (for example, the origins of unemployment).

According to Voss and Post (1991), this may partially be explained by the existence of two classes of problems: well-structured (single solution, single representation) problems and ill-structured problems (multiple solutions, multiple representations). In this view, the field of economics is dominated by ill-structured problems having multiple representations. This may largely account for the differences among experts in economics. The present study attempts to investigate differences in problem representations between expert and novices in economics. It was designed to assess differences in knowledge bases of economics by employing "real world" problems. These are problems to which novices have been exposed in "real world situations" like unemployment, inflation, but which are also addressed in the educational program when teaching economic theories. Two experiments were conducted to examine the existence of problem categories in economics as a basis for problem representation. The first study examined what kind of categories were used for problem solving, and how experts and novices differ in indexing a particular problem in a

particular category. The second study investigated whether experts use stable categories when analyzing problems.

Method

Subjects. We asked 6 experts (professors, having more than 10 post-graduate years experience) from the economics department, 6 intermediates (fourth year university students, from the final year in the economics programs), and 6 novices (first years university students majoring one semester in economics).

Procedure. The objective of the first study was to determine the kinds of categories subjects, of different experience, impose on problems. A sorting procedure was used to categorize 18 problems at the level of the end of the first year economics program. Each problem was typed separately on cards. Instructions were to sort the 18 problems into groups based on similarities of solution. Subjects were not allowed to use paper and pencil during problem-solving. After sorting the problems they were asked to write down the problem-numbers, and give a description of the category. In addition, time was measured in minutes for each sorting trial.

The objective of the second study was to determine the stability of sorting procedures among experts. Six weeks after their first sorting, experts were asked again to sort the same set of 18 problems. The conditions for the second sorting were the same as in the first sorting experiment. After sorting the problems, experts were asked to comment whether they remembered their categorization from the first trial. Six weeks after the second trial one expert was asked to resort the same set of problems again in a third trial. This time the instruction was to make as many meaningful sorts as possible, and comment afterwards on the reasoning followed during the sorting.

Materials. Chi, Feltovitch and Glaser (1981) found that novices grouped together problems that have the same surface structure, experts grouped problems around underlying principles. To assess whether the same results may be found in the domain of economics, a special set of problems was constructed by the researchers of the present study (an experienced economist and an educational psychologist). The set

of 18 problems was designed to cross surface features roughly with applicable theories / laws in economics that explain the underlying mechanisms / phenomena. The problems all had the same format, at the end of first-year level. For example, problem 6 contained the following text: "*Many Dutch companies consider it too expensive to reduce pollution of the environment. However, they appreciate the existence of international laws in this particular area. Explain*". Table 1 shows the problem numbers and the dimensions on which these problems were varied. Consequently, we expected that novices would, for example, categorise problem 6 as a "Pollution problem", while experts' categorisation would be "Social Dilemma" (appendix 1 contains the full text of the set of problems).

Table 1: *Problem categories.*

			Principles		
Surface Structure	Social Choice	Business cycle	Structural Adjustment	Social Dilemma	Disequilibrium prices
Unemployment		1, 16	2, 17, 18	3	14
Pollution	15		13	6	
Inflation		5, 12		7	4
Protectionism	8		9, 10	11	

Variables. The first study focused upon, time required to solve the problems, number of categories produced, and a qualitative analysis of the categories with respect to the use of surface structures or deep structures. The second study examined the stability of sortings, time required, and a qualitative analyses of the categories produced.

Results and Discussion

Study 1. No differences were found in the average number of categories (mean = 5.3) produced per sort between different groups. Each group used about 5 categories to sort the problems. However, groups differed qualitatively with respect to the labels or names of different categories used to describe the sorts. Novices produced in total 12 different labels for categories, intermediates 20 labels for categories and experts 17 labels.

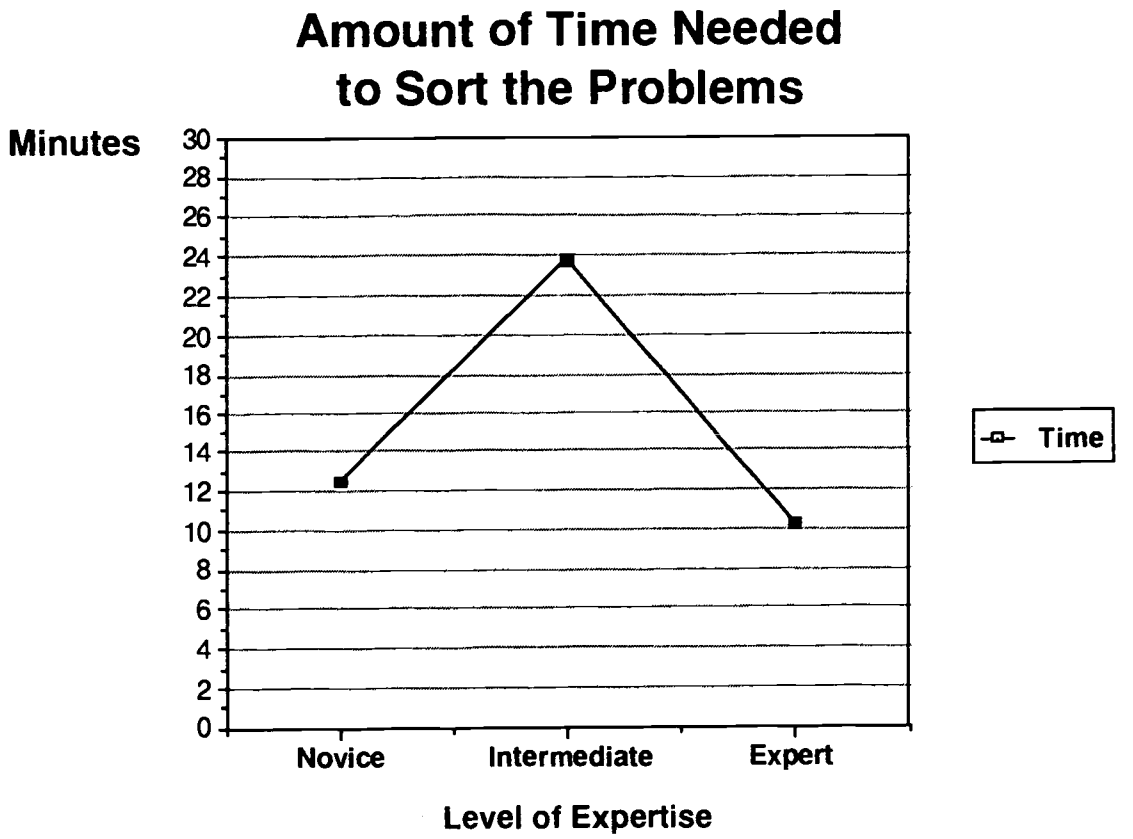

Figure 1: *Sorting time*

The categories used by novices were typically one word descriptions at the surface structure of problems, e.g. pollution, or unemployment. In contrast, intermediates and experts used descriptions commonly used in economic theories. Experts typically used one word descriptors at the deep level. However, intermediates used explanatory frameworks, based on deep level constructs, of more than one sentence to describe the categories. There were also differences found in the amount of time it took to sort problems. Intermediates used nearly twice as much time to produce sorts than novices or experts. Figure 1 and 2 contain the results of study 1.

More insight in the ways subjects categorize problems is possible through analyzing the labels / descriptions subjects gave for the categories they produced. Novices typically used labels at the surface level. Labels which were also used as descriptors or cues incorporated in the text of the problem.

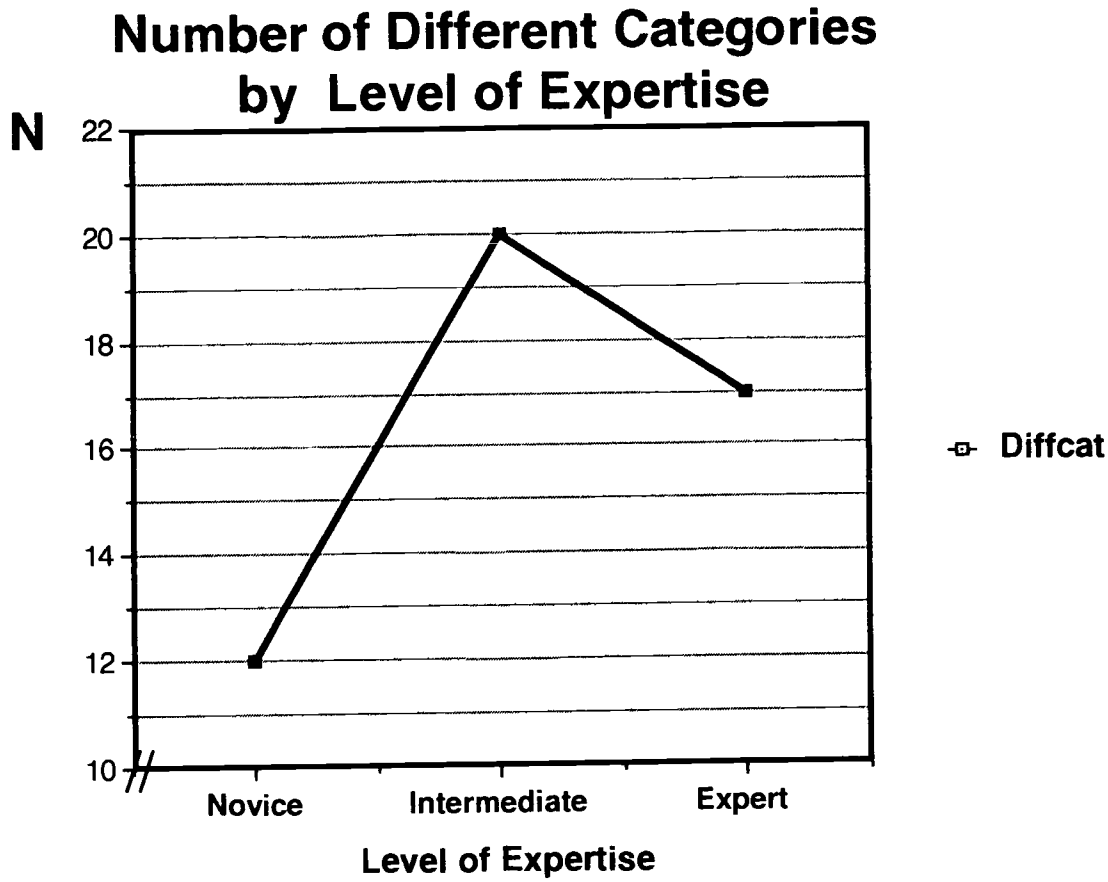

Figure 2: *Number of Different Categories*

Intermediates and experts differed from novices by their usage of a larger knowledge base than novices. Especially, intermediates used more labels to sort the problems. It was also found that experts only tended to show expertise for a subset of domains. Typically, they sorted two subsets of problems (subset 1: problem 8, 9, 10, 11 & subset 2: problem 6, 13, 15) on a surface level, whereas the other problems were categorized at deep structure level. Intermediates assigned the lowest number of problems into surface level categories.

Study 2. The second study examined the stability of sortings by experts. Time needed to resort the problems in second trial was 9.4 minutes (about one minute less than during the first trial. The number of categories produced was the same as in the first trial (5.3). Qualitative analysis of the second trial showed that experts used only consistent sortings with respect to the surface level categories "pollution" and "protectionism". Those experts who had used surface categories in their first sorting

also used them in the second sorting. Small differences appeared in the deep level categories. Experts tended to shift problems to different expert categories. This resulted in new labels for the expert categories, or expert categories stayed the same consisting of different sets of problems.

When it was found that experts were not as consistent in their sortings as compared with the physics experts in the Chi et al. (1981) study, a third trial was organized for one expert. Again he got, about six weeks after the second trial, the same set of problems. As noted, he was instructed to make as many meaningful sorts as possible, and comment afterwards on the reasoning followed during the sorting. Again, consistent results were found with respect to the surface categories "pollution" and "protectionism". The remaining problems were categorized in new expert categories, although familiar with previous expert categories. At the end of the third trial the expert was asked to comment on all his trials. He mentioned that he only felt having sufficient expertise on the "structural adjustment problems" and "disequilibrium prices". Essentially, he felt that his sortings were stable to these dimensions, because problems were always grouped around these dimensions. The organization of problems around surface features was explained by the focus of his professional academic work. He was never confronted scientifically with these problems since graduation.

The exploratory studies reported in this paper largely confirm the findings of Chi et al (1981). Experts differ from novices by solving problems based on categories that contain major economics principles. It was also found that experts grouped a set of problems similar to those of novices. Experts explained this result by their kind of specialisation in academic work after graduation. By contrast, intermediates tended to have different, deep level, representations of these problems. The findings of the present study differ from Chi's findings with respect to the stability of sortings. Experts produced only stable resortings for problems that were encoded in a novice way. Problems that were encoded at the deep level either showed in essence the same dimensions (containing slightly different problem groupings), or showed new categories

that consisted of newly grouped problems. The latter finding may be explained by the ill-structured nature of economics problems or by the experts' cognitive flexibility.

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Appendix 1

Full text of the set of 18 problems

1. At the end of the Eighties a strong increase in unemployment occurred. This is largely due to restrictions in monetary policy-making. Explain
2. The unification of the EC, going together with abolishment of tariffs of duties, resulted in increases of unemployment among customs officers. Explain.
3. In the Thirties a strong increase in unemployment occurred. This resulted in the risk of unemployed workers trying to get a job by negotiating and accepting lower wages. This problem may be solved by declaring collective labour agreement as force of law. Explain.
4. At the end of the Fifties it was attempted to suppress inflation by keeping wages low. Consequently, this resulted in a lack of qualified workers, being observable in payment of wages above the agreed/union rate and attracting foreign labour. Explain.
5. During the Seventies, prices of nearly all goods largely increased. This was partly due to a sharp increase in money supply during this period. Explain.
6. Many Dutch companies consider it too expensive to reduce pollution of the environment. However, they appreciate the existence of international laws in this particular area. Explain.
7. Labour unions demanded during the Seventies higher wages. This was partly due to sharp increases in social security contributions. Companies accepted higher wages to prevent social unrest. Consequently, wages increased even more. Explain.
8. Many protective decisions are introduced as temporary. However, most of them get permanent. Explain.
9. Many developing countries plea for protectionism. Because every imported product increase the international debt of these countries resulting in large financial problems. Explain.

10. At the end of the Nineteenth Century low transportation costs and the end of US civil war, made it possible to export cheap grain to Europe. This resulted in an European crises and stimulated protectionism. However, this protectionism was unfavorable for European countries. Explain.

11. During the Thirties the US protected its economy by high tariffs of duties (Smoot-Hawley Act). This protectionism forced other countries protected their own economy. Finally, the US economy had a bigger problem at the end then at the beginning of protectionism. Explain.

12. During the Sixties it looked like low inflation may result in low unemployment. This idea made it acceptable that Government stimulated actively its economy. It took many years before government realized that inflation was no longer under control. Explain.

13. Even after it was found that pollution became alarming and a public threat, and legislation was adapted, it took many years before this resulted indeed in reducing pollution. Explain.

14. During the Seventies wages increased more than labour productivity. At the begin of the Eighties unemployment rates were extremely high. Explain.

15. Employers often strongly resist against tariffs of reduce pollution. One of their arguments is that tariffs not only regulate, but also provide income for Government. Accordingly, Government will attempt to increase tariffs to secure their income. Explain.

16. During a recession, Government can apply a liberal monetary policy to reduce unemployment. But this not advisable from an economist's point of view. At the long-run this policy will result in even more unemployment. Explain.

17. The strong growth in computerization of offices resulted in an increase of unemployment rates. Explain.

18. Unemployment in the Netherlands increased. This is partly due to cheap import of textile fabrics from developing countries. Explain.

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