Problem Solving and Creative Thinking in CEGEP Curriculum:

Evaluation, Recommendations, Course Proposals and Annotated Bibliography

Fouad Assaad (Ph.D)

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Cette recherche a été subventionnée par la Direction générale de l'enseignement collégial dans le cadre du Programme d'aide à la recherche sur l'enseignement et l'apprentissage.

On peut obtenir des exemplaires supplémentaires de ce rapport de recherche auprès de la Direction des services pédagogiques du collège Champlain, Campus de St-Lambert-Longueuil.

L'auteur de cette étude voudrait remercier la Direction générale de l'enseignement collégial, le ministère de l'Éducation et le Gouvernement du Québec pour leur appui financier. L'auteur tient également à remercier la Direction du Collège Champlain pour son aide en ressources humaines et techniques. En plus, un merci tout spécial à Mme Samia George pour le développement des programmes statistiques, M. Brian Aboud et Mme Salwa Ismail pour avoir codé les données, et finalement au groupe d'assistantes en recherche: Mmes Suzy Poulin, Sharon van Rassel, Lisa Neufeld et Wendy Mitchell. L'espace disponible limite le prolongement de cette liste, mais un grand merci va à tous les étudiants du Collège Champlain qui ont contribué au projet.

FOUAD ASSAAD

Résumé

Cette étude a évalué l'adéquation d'un nouveau cours de Résolution créative de problèmes pour les élèves et élèves de l'ordre collégial. Le développement d'un tel cours est le résultat d'une évaluation expérimentale de six cours et programmes importants offerts dans des institutions post-secondaires.

Ces programmes sont les suivants : (1) **Solving problems creatively** d'après le Module multimédia CRM, McGraw-Hill, 1982; (2) **Patterns in Problem Solving** de l'Université de Californie à Los Angeles (UCLA); (3) **Applied Problem Solving Through Creative Thinking** de la Société américaine de Chimie (ACS); (4) La méthode **CORT Thinking** de DeBono; (5) Le cours Creative Problem Solving (**CPS**) du Collège Champlain; (6) et enfin les ateliers Creative Problem Solving Workshop (**CPSW**) toujours du Collège Champlain.

Les résultats de l'évaluation et de la comparaison ont montré que le nouveau cours a contribué de façon modérée à la connaissance de la résolution de problèmes, mais que ceci était compensé par sa contribution au développement d'autres habiletés relatives à la résolution de problèmes. Ainsi, le nouveau cours a révélé des résultats positifs en ce qui concerne les attitudes, les habiletés, la créativité et les aptitudes.

Pour chacune de ces variables, le nouveau cours s'est placé soit en première sait en deuxième place, selon la variable. Il s'est avéré très utile pour le développement du raisonnement, de l'analyse opérationnelle, du classement et de l'analogie verbale. Il a eu un effet important sur les attitudes des élèves par rapport à la résolution de problèmes.

En ce qui concerne l'évaluation du processus et de l'expérience d'apprentissage, les élèves ont déclaré qu'ils étaient satisfaits de ce qui avait été présenté dans le cours et de la façon dont cela a été présenté. Sur ces points, il n'y avait pas de différence majeure entre le nouveau cours et quatre des six cours mentionnés (ACS, DeBono, CPS et CPSW).

Enfin, en ce qui concerne les répercussions du cours sur le rendement scolaire des élèves dans les matières faisant appel à la résolution de problèmes, le nouveau cours s'est classé deuxième, derrière le CPWS qui utilise le format des ateliers.

Il est recommandé qu'un cours de Résolution créative des problèmes soit introduit à l'ordre collégial, et que les principes de la méthode soient intégrés au curriculum. Des exemples d'objectifs de cours et de contenus sont inclus.

Une médiagraphie et une liste des personnes-ressources et des institutions ayant une expertise en ce domaine a été compilée. Elle pourra être utile à ceux et celles qui veulent introduire un

cours de Résolution créative des problèmes. Sur demande, il sera possible d'obtenir une bibliographie annotée des titres anglais et français sur le sujet, y compris les plus récents; les résumés des articles les plus importants et une liste de revues et des bulletins spécialisés seront aussi fournis. Une description des cours et des programmes d'enseignement les plus importants en Résolution des problèmes et en créativité est aussi incluse, de même que la liste des institutions où ils sont offerts.

Abstract

This study assessed the suitability of a **new creative Problem Solving Course** developed for **CEGEP** students. This course is based on the evaluation of six major courses and programs offered at post secondary institutions.

These programs are: (1) CRM Multimedia Module **Solving Problems Creatively**, McGraw-Hill Inc. 1982. (2)- The UCLA **Patterns in Problem Solving,** the American Chemical Society's Program **Applied Problem Solving through Creative Thinking,** the DeBono's **Cort Thinking,** the Champlain Regional College Creative Problem Solving Courses (**CPS &CPSW**).

The Results from the evaluation and comparison revealed that the new course contributed moderately to Problem Solving Knowledge, but this was balanced by its contribution to develop other skills.

The new proposed course revealed positive results on problem solving strategies, attitudes, skills, creativity and aptitudes. It either ranked first or second. It was extremely useful in developing reasoning, operational analysis, figure classification and verbal analogies. It play an important role in changing students attitude toward problem solving courses.

Regarding the process and experiential variables students agree with the information presented consider them valuable and meet their needs. There was no major differences between the new courses and most of the others. (Reid's, DeBono's the CPS and CPSW).

Finally with regard to the impact on students academic performance in improving other courses with problem solving nature. The new course ranked second behind the CPSW which applies the workshop format.

It is recommended at the post-secondary level (**cegep**)that, a **creative problem solving course** be introduced, and integrating **problem solving** in the whole college curriculum.

A source materials component designed to make this goal attainable has been prepared as an inservice and resource tool to assist professors at the post-secondary level to introduce and teach creative problem solving courses within their institutions or within their curriculum. It makes available, **on request**, an annotated bibliography of the major up-to-date English & French language books in this field and list of the scientific abstracts for the major articles published to date . Major programs,courses,institutions teaching problem solving and creativity and prominent experts in the field are also available.

FORWARD

The ability to meet and overcome problems is a lifetime skill that every person needs in order to be able to survive in the future society. Educating today's students to meet the problems of tomorrow requires a careful blend of traditional basic-skill instructions and opportunities to apply those skills to real situations. The person who is deficient in either the fundamentals or in the application of the techniques and strategies will be handicapped in his/her ability to cope with daily problems.

Creative problem solving has long been recognized as an educational goal. As we approach the 21st century, it is becoming an increasingly important area of competence. Any institution or organization which underrates this goal will have to face the consequences in the future. It should be underlined here, that equipping students with the appropriate problem solving skills for the future requires careful curriculum planning and the introduction not only of separate creative problem solving courses, but also of problem solving principles in the whole curriculum.

The objective of this study is to evaluate creative problem solving courses and programs. It has been prepared as an inservice and resource tool to assist professors at the post-secondary level to introduce and teach creative problem solving courses within their institutions or within their curriculum. This report includes a comprehensive source materials component designed to make this goal attainable. It also includes or makes available, on request, an annotated bibliography of the major up-to-date English & French language books in this field. A list of the scientific abstracts for the major articles published to date as well as major programs, courses and institutions teaching problem solving and creativity, and prominent experts in the field is also available. Major issues in teaching problem solving in specific fields such as math, physics, chemistry, computer science, social science and so forth are also identified.

I hope that this study and the available information will facilitate both the instruction of creative and it's integration it in the whole college curriculum.

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Contents

Introduction:

A significant part of current investigation in cognitive science, developmental psychology, and the study of human intelligence is concerned with the ability of people to reason, understand and solve problems. Current research is contributing to our understanding of the nature of human thinking and problem solving in general. However, at the present time, our schools continue to teach knowledge of the "content" without encouraging thinking, mindfulness, and problem solving. Research in this area supports one major conclusion: Problem solving strategies should be taught (Suydam, M.N., 1982). Consequently, many post-secondary institutions have adopted different problem solving systems and programs (Glasser, 1984: 95,96).

Since 1981, Champlain Regional College has been specially interested in developing this area by offering three problem solving courses: Creative Problem Solving (CPS), Creative Problem Solving Workshops (CPSW) and Games and Decisions which teaches DeBono's Cort Thinking Course (CORT).

Since that time the author has been involved in the area and has produced a manual entitled Creative Problem Solving (1981) and Creative Problem Solving Workshop (1983) designed to develop the above mentioned skills.

In 1986, the author received a three year research grant from PAREA[1] to evaluate the system developed along with some of the major well-known and recognized post-secondary North American Programs. The main objective was to determine the suitability of these programs for students at the Cegep level, and to determine which variables should be considered in teaching any problem solving course at this level.

During the 1986/1987 academic year, the Champlain Creative Problem Solving Program (CPS, CPSW and CORT Thinking) was evaluated (Assaad, 1987). Then, in 1987/1988 the following programs were eveluated:

The University of California, (UCLA) Patterns of Problem Solving by professor M.F.Rubinstein; The Applied Problem Solving of the American Chemical Society, by David Reid; the CRM Multimedia Module Solving Problems Creatively by E. Patricia Birsner in consultation with James L. Adams, Associate Dean, School of Engineering, Standford University (Assaad, 1988).

[1] La Direction Générale de L'Enseignement Collégial, Programme d'Aide à la Recherche sur la Pédagogie et L'Apprentissage, Ministère de L'Enseignement Supérieur et de la Science.

Finally during 1988/1989, a new course based on the evaluation of the previous six courses, was developed and tested.

This report will determine the impact of teaching this last course (known henceforth as the "newly proposed course ") on CEGEP students' problem solving strategies, skills, attitudes, aptitudes and creativity. The results will be compared with the other six courses previously evaluated. The report will also include a description of certain programs, textbooks, available resources and recommendations regarding the place of problem solving in the CEGEP curriculum and the ways it can be taught (sample course objectives will be included in the report).

PART I:

GENERAL EVALUATION OF PROBLEM SOLVING PROGRAMS

The acquisition of enhanced reasoning, understanding, and problem solving ability has been questioned since the beginning of this century. This was evident reactions to E.L. Thorndike's "connectionist conception" of the higher level thinking process. For example Glaser has stated,

> "His studies fostered the development of curricula that emphasized the specificity of learning and direct experience with the skills and knowledge to be learned, because he had concluded that transfer effects were minimal. His ideas on the specificity of learning supported forms of instruction that many feared failed to encourage the development of higher levels of thinking" (See Glaser, 1984:93).

Despite the dominance of connectionism, interest in establishing a cognitive basis for a pedagogy that fosters thinking and reasoning in school learning has been continuously expressed by researchers. Dewey (1896), spoke of learning in terms of aims, purposes and goals, and problem solving or intelligent action. William Brownell (1928, 1935), George Katona (1940) and Max Wertheimer (1945, 1959), opposed Thorndike's drill and practice, and encouraged the development of understanding. In the late 1950s and early 1960s, behavioristic psychology and its programmed instruction strongly influenced instructional theory. Modern theories are now contributing to the teaching of reasoning and understanding (Taber, Glaser, & Schaefer 1965; Bruner, 1964).

The utilization of older theories was widespread and their impact and limitations are manifested today. Studies on the schooling process show that elementary skills such as reading, sound-symbol correspondence, decoding from print to sound, phoneme word recognition, higher-level processes and the acquisition of inferential and critical thinking are not being acquired. In mathematics, an increase in the performances associated with basic skills and computationm has been reported while improvement in mathematical understanding and problem solving has been negligible(National Assesment of Educational Progress, 1981). The evidence is reiterated in science education. for instance,Champagne and Klopfer (1977) point out that despite the commitment of science educators to the principle of scientific thinking, it is not adequately reflected in practice. Although there has been much work put into defining objectives of science instruction which specify problem solving ability, tests that assess it are far from satisfactory. Indeed, it is clear that the acquisition of creative problem solving skills by students has been minimal at best. This situation is true not only in the United States, but also in Quebec and throughout Canada. The Canadian need for developing problem solving skills was demonstrated by the University of Waterloo's study (Woods, Crowe, Hoffman and Wright, 1977). In Quebec, the concern for developing critical thinking was documented by the "Programme de devéloppement de la pensée formelle developed by Le groupe Démarches ' - Collége de Limoilon, 1986" (Démarches, 1986).

PROBLEM SOLVING PROGRAMS

To overcome the lack of adequate problem-solving skills among many post-secondary students, certain programs and textbooks have been developed. These programs are classified into the following four categories: Process Oriented Programs; Context of Generally Familiar Knowledge; Problem Solving Heuristics in well Structured Domans;Teaching Problem Solving Competence Throughout the Curiculum.

1 PROCESS-ORIENTED PROGRAMS

These programs are geared towards developing habits of reasoning and skills of learning to improve performance of a general metacognitive, self-monitoring procedure. They are designed to counteract the poor problem solving performance which has been attributed to errors in reasoning and general cognitive deficiences. And on this basis they offer mainly problem solving strategies and steps. Among the many programs developed in this category are:

1.1 The CRM Multimedia module (1982), Solving Problem Creatively , developed by E. Patricia Birsner in consultation with James L. Adams, Associate Dean, School of Engineering, Stanford University. This is a program dealing with the concepts and skills of problem solving with special emphasis on the creative aspects of defining a problem and producing ideas. The latter stages of problem solving - evaluation, decision-making and implementation - are introduced for a basic understanding, but are not studied in depth. This program is flexible and suitable for the college level as a short course or to complement other courses. This program will be evaluated in depth below.

1.2 Another example is the Creative Problem Solving program developed by Fouad Assaad (1981). Three different courses applying three approaches to teach creative problem solving have been developed. These courses are: Creative Problem Solving (CPS), Creative Problem Solving Workshop (CPSW), and Games and Decisions. They attempt to overcome the difficulties mentioned earlierand to respond to the general and academic concerns about this skill. The approach used to teach CPS is mainly discipline through cognitive learning . A combination of discipline and problem solving cases is used to teach the CPSW course. Games and Decisions,meanwhile, is based on problem solving cases with an emphasis on such elements as creativity. An affective learning approach is applied and the problems used are mainly judgmental and creative, require mainly the exercise of judgment and creative thinking where there is no correct answer. In the CPS course, the emphasis is on strategy, or the steps for solving problems. The types of problems utilized in the CPS course are mainly analytical, requiring logical reasoning. These analytical problems can be classified under ordinary homework or open-ended types which require the decision-maker to generate many alternative solutions and select the correct one. An evaluation of this program was completed in 1986/87 (Assaad, 1987).

1.3 A third program was developed by Whimbey and Lochhead (1980), and is entitled, Problem Solving and Comprehension: A Short Course in Analytical Reasoning. The basic materials were prepared by Art Whimbey and were available as standardized mimeo notes. They were used in this form by many schools, especially by Jack Lochhead at the University of Massachusetts. Whimbey and Lochhead worked together to produce a more readily available version in 1979. It was revised in 1980, and again in 1984 .This program requires thinking aloud to a partner about the steps taken in solving problems of the sort used in intelligence, aptitudes, and achievement tests. The partner points out errors, but does not correct them. Art Whimbey states that, "Tutors should not just give answers or demonstrate the way a problem can be solved. They should help students find answers for themselves. How often we fall into the trap of saying, 'oh, here is how you do it', instead of requiring that the student interpret our hints and actually carry out the activities and computations." (Woods, 1980 - 10). The program assumes that few errors are made because of lack of knowledge of vocabulary or arithmetical facts.Rather they are attributed to shortcomings/weakness in reasoning such as failing to observe and use all the relevant facts of a problem, neglecting to approach the problem in a systematic, step-by-step manner, jumping to conclusions, or failing to construct a representation of the problem. Through carefully designed problem exercises, the program elicits procedures for reasoning and problem solving that avoid these errors (Glasser, 1984:95).

2 CONTEXT OF GENERALLY FAMILIAR KNOWLEDGE

An example belonging to this category is:

2.1 The CORT Thinking Program (Cognitive Research Trust) developed by Dr. Edward de Bono. This program is described in de Bono's books entitled Teaching Thinking (1978), The Use of Lateral Thinking (1976), De Bono's Thinking Program (1981), Lateral Thinking for Management, Oppurtunities, Future Positive, The Atlas of Management Thinking, Tactics: The Art and Science of Success, and Thinking Hats. Although these books provide the level of detail needed to implement the program, This study is concerned specially with de Bono's thinking program published in 1981. This program is composed of six groups of ten units, teachers' notes for each group, and ten separate sheets for each group.

The importance of considering and evaluating de Bono's program is related to its appropriateness at the college level. Dr. D.R. Woods, in his review of the program stated that it is "very appropriate for the College Science and Mathematics, although we have to look beyond the acronyms and cartoon flavor of the original and adapt it for use" (Woods, 1984). It should also be noted that the program is easy to implement and its sixty units can be used with very little modification. The materials are nonhierarchical. This program emphasizes skills that are not dependent on the prior acquisition of curriculum subject matter. However, unlike other programs (Whimbey and Lochhead and Feuerstein), the CORT program keeps away from puzzles, games, and other such abstractions (Glaser, 1984:95).

The CORT Thinking lessons are now the most widely used materials for the direct teaching of basic skills. They are used in the U.K., Eire, Australia, New Zealand, Israel, Malta, Venezuela, and, increasingly in the United States and Canada (de Bono, 1981:1) Recently the CORT Thinking program has also been applied by some of the business corporations in Europe, the United States and Canada. This program was evaluated during 1986/87 and results are reported in this study (See Assaad, 1987).

2.2 Another program belonging to this category isthe one developed by Covington, Crutchfield, Davies, and Olton (1974) entitled, The Productive Thinking Program: A course in learning to think. It is considered a major source program because of its format and the availability of training workshops that can be used by others to develop training programs or courses. It is composed of a series of fifteen lessons or books, each having the same format consisting of a story about a problem being solved (approximately 40 pages long), a challenging set of problems, a summary, and a class exercise. The layout, presentation, feedback and reinforcement components are excellent. The content focuses on about a half-dozen key heuristics for problem solving

(Woods, 1984:35-18). The students are led through a problem solving process and at appropriate points are required to state the problem in their own words, formulate questions, analyze information, generate new ideas, test hypotheses and evaluate possible courses of action. These procedures are formulated as thinking guides that are presented throughout the various lessons and problem sets (Glasser, 1984:95). This material is presented through story of the adventures of two senior public schoolers and their wise detective uncle. The setting is inappropriate for the college level, yet the ideas are useful.

2.3 A third pogram in this category is the "Guided Design" program developed by Dr. Charles Wates for West Virginia University. This program is available with a new enrichment by Charley W. and Anne Hardi: Successful Decision-Making (1984). This system is explicit with strategies and students are given the opportunity to cope with all the components of problem-solving. The educator's challenge in this program is to create the problem situations, to write out the questions and activities that guide the students through the issues to be considered, to create the feedback materials and where pertinent, to develop the self-paced subject enrichment materials.

3 PROBLEM-SOLVING HEURISTICS IN WELL-STRUCTURED DOMAINS

This category of programs is concerned with teaching skills in problem solving, particularly in formal, well-structured domains like mathematics, chemistry, physics and engineering.

3.1 George Polya (1957), How to solve it: A new aspect of mathematical method, is considered to be a guiding spirit in this category along with Newell and Simon (1972) (cf. Glaser, 1984:96). Polya recommends that explicit attention be paid to heuristic process as well as to content. He suggests a variety of helpful ideas such as: looking for analogical situations; looking for solutions to partial auxillary problems; decomposing a problem and recombining elements; checking whether the conditions presented in a problem are sufficient, redundant, or contradictory; and working backwards from a proposed solution. He also discusses more specific procedures with his four-step strategy. Dr. Woods (1980) prefers Schoenfeld's approach over Polya's because "modern research has clarified the Define Plan Steps much better than Polya presents it". He also states that "unfortunately, this four step strategy does not highlight by name the step when we create the internal representation (or as Lee has called it "the problem translation skill"). Students do not realize that it is good to play around with the problem situation and explore it "(Woods, 1984,40). There are other programs and publications which are more suitable for use at the high school level such as Solow (1982), How to Read and Do Proofs; TOPS for Kindergarden children to grade 12, and the Lane County mathematics program for grade 4 to 8 (Schaaf, 1983). The value of these programs for those outside mathematics and at the college level is in providing ideas such as the student workbook in TOPS.

3.2 Another very well-known program in this category is Pattern of Problem Solving developed by Rubeinstein (1975). This program was evaluated in depth (Assaad 1988). The results are reported in part II of this study. The value of this program is found in its introduction of a wide range of specific problem solving techniques that can be used on problems encountered in students various specializations. Moshe Rubinstein's course, "Patterns in Problem Solving", is a course that is offered campus wide at the University of California, Los Angeles (UCLA). It was designed to provide a foundation for attitudes and skills which are productive in dealing with complex problems in the context of human values. The documentation for this course is excellent.

There are three texts (Rubinstein, 1975; Rubinstein and Pleiffer, 1980 and Rubinstein 1986), and nineteen videotaped lectures. This course was chosen to be evaluated at the college level because of its usefulness in developing reasoning skills in the process of problem solving and decision-making. It is considered to be appropriate for college science and mathematics (Woods, 1985). "Patterns of Problem Solving" was introduced in the fall of 1969 and attracted only thirty-two students. Enrollment has since increased to exceed 1500 students per year and more than twelve sections (Manus, L. A and Zipser, D. 1977). Coupled with the increasing enrollment is an increase in the number of instructors teaching the course occured with background in various fields including engineering, artificial intelligence, reliability, science, computer science, psychology and social science. A Peer Program was also developed and evaluated between 1974 and 1977. UCLA offers "Applied Pattern in Problem Solving" as an elective course, with "Pattern in P.S." as a prerequisite. The objective of this course is to expand the coverage of problem solving and to identify and develop peer teachers for the "Pattern" course. Some background about these courses and others who have implemented variations of Rubinstein's course is explained in M.F. Rubinstein's "A Decade of Experience in Teaching an Interdisciplinary Problem-Solving Course" (Rubinstein, in Tuma and Reif, 1980). What is being evaluated in this study is the original "Pattern in Problem Solving" with the nineteen video tapes.

3.3 A similar program, but more process oriented is Applied Problem Solving Through Creative Thinking (1977), developed by Dr. J.D. Reid for the American Chemical Society. This program was also subject to an in depth evaluation (Assaad 1988). Reid introduces student to both a nine-step system for creative problem solving and to such problem solving techniques as deliberate creativity, the Innotech method, synectics, and Force-Field Analysis. The program also consists of video tapes and a manual to be used complementarily. Dr. Reid is the author or co-author of some 206 scientific publications plus 39 U.S patents and several foreign patents.

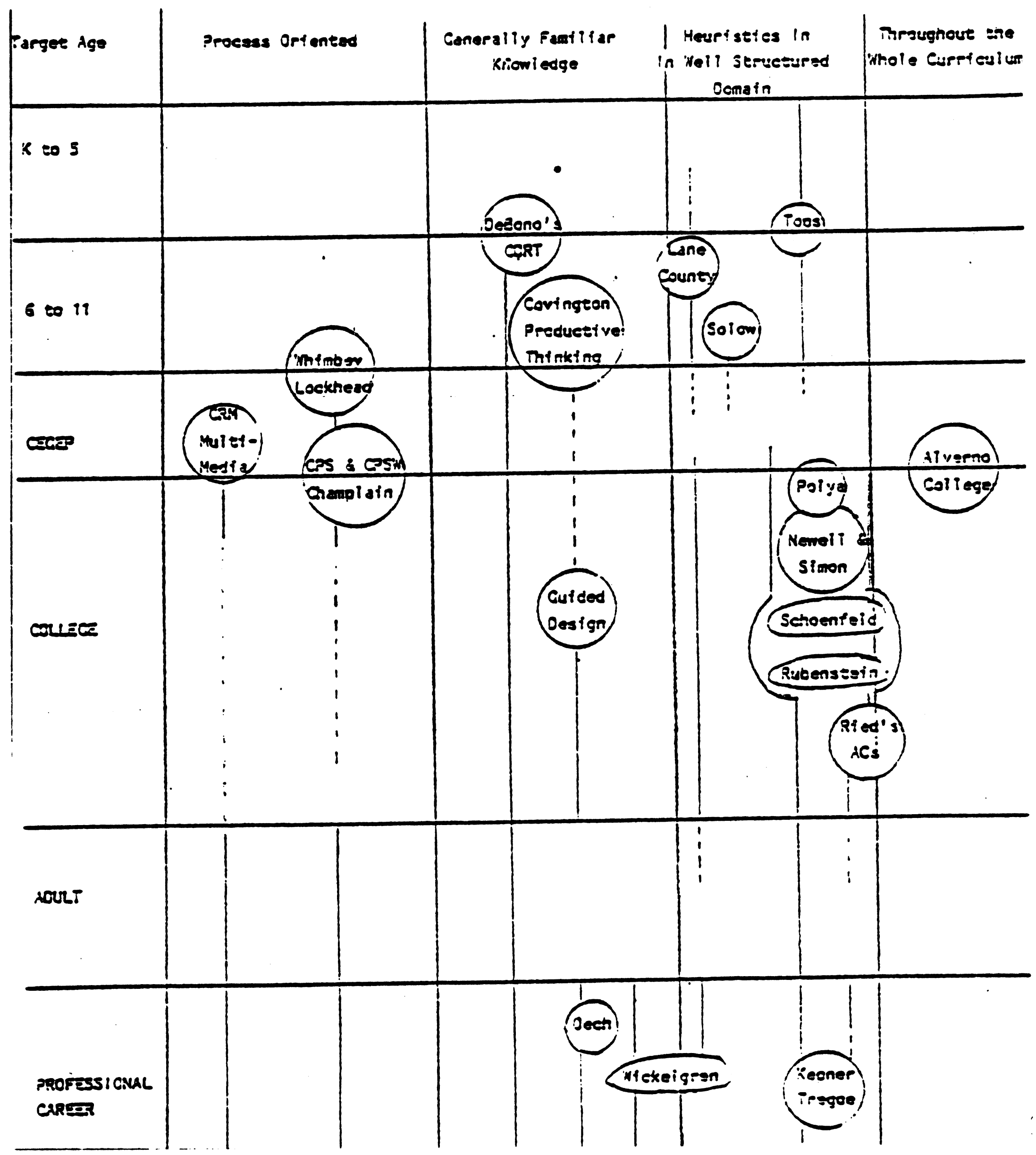
Other programs of this genre are Kepner Tregoe (1965), Sanderson (1981) and Roger Von Oech (1983 and 1986). These are mainly industrial training programs. Hayes' work (1981) is entitled The Complete Problem Solver, and Wickelgren's (1974) is entitled How to Solve Problems: Elements of a Theory of Problems and Problem Solving. These text books were designed to improve the reader's ability to solve mathematical, scienific, and engineering problems.

4 TEACHING THE PROBLEM SOLVING COMPETENCE THROUGHOUT THE CURRICULUM

The **Alverno College** Program aims at fostering problem solving and thinking skills at college level throughout the whole curriculum. Problem solving has generic competence and is taught in a variety of formats and course structures in the first two years of the general education sequence for all students. The program utilizes the perspectives of multiple disciplines. In order to graduate, each student must demonstrate competence in eight different areas within the context of the liberal arts and the student's major. Problem solving is one of the eight competences. Within the context of at least three discipline areas (for example, introductory chemistry, developmental psychology, and statistics), a student learns to identify each discipline's "macro" problem solving process. In further courses the learner must demonstrate the ability to state problems, solve problems and finally compare the heuristics used in each problem situation. Throughout the process, the student receives feedback on his strengths and weaknesses and learns to assess his own problem solving skills (O'Brien, 1980).(See Figure No. 1.)

FIGURE No. 1

PROBLEM SOLVING PROGRAMES CLASSIFICATION AND EDUCATION LEVEL



These are samples of current practices that are evident in published programs and texts used in various educational institutions in North America. To find out the suitability of these programs for CEGEP students and the most relevant variables and areas to be considered in teaching problem solving at this level, an in-depth empirical evaluation of selected sample programs was completed in 1988 .(Assaad 1988).
The importance of this evaluation rests on its contribution to theory and knowledge of human thinking.

There are two sets of theories in human cognition. The first set stems from psychometric notions of inductive reasoning and the concepts of divergent thinking. They are derived from the information-processing theory that explores knowledge and concentrate on the basic information processing capabilities humans employ when they face problem situations where specialized knowledge is lacking. The theoretical contributions of Newell and Simon (1972); Newell (1980) and others (eg. Greeno, 1978; Woods, 1984) should be considered at this point. Their general conclusions indicate that humans solve problems according to basic heuristic processes.

The second set is related to learning and thinking that requires domain-specific knowledge. As Glaser puts it, "The results of this newer research and theory force us to consider the teaching of thinking not only in terms of general processes, but also in terms of knowledge structure - process interactions" (Glaser, 1984:97). The theoretical contributions of Chi and Koeske's (1983); Chase and Simon, 1973; Chi, Glaser, Rees, 1982; Larkin, Mc Dermott, Simon and Simon, 1980; need to be considered.

The systematic testing of the three different programs contributed to the the literature by filling the gap concerning the suitability of these courses for college students at CEGEP level.

PART II:

EMPIRICAL EVALUATION OF THE NEW PROPOSED COURSE

Based on the evaluation and testing of the previous programs, the most suitable problem solving elements and strategies were identified. Consequently, we were able to control for the variables that should be considered in teaching any problem solving course (or program) at the CEGEP level.

The variables that are involved in developing the higher-order ability of students to reason, understand and solve problems are reported in Table 1. These variables were put together to form a new course tailored and desig'ied for CEGEP students. It constitutes a synthesis of those elements which revealed the most reliable results.

RESEARCH QUESTION

To what extent does teaching the newely developed Problem Solving Course affect the CEGEP students' problem solving knowledge , strategies , skills , attitudes , aptitudes and creativity? . What materials are available to assist and enrich the whole college curriculum?.

OBJECTIVES

The purpose of this research is to:

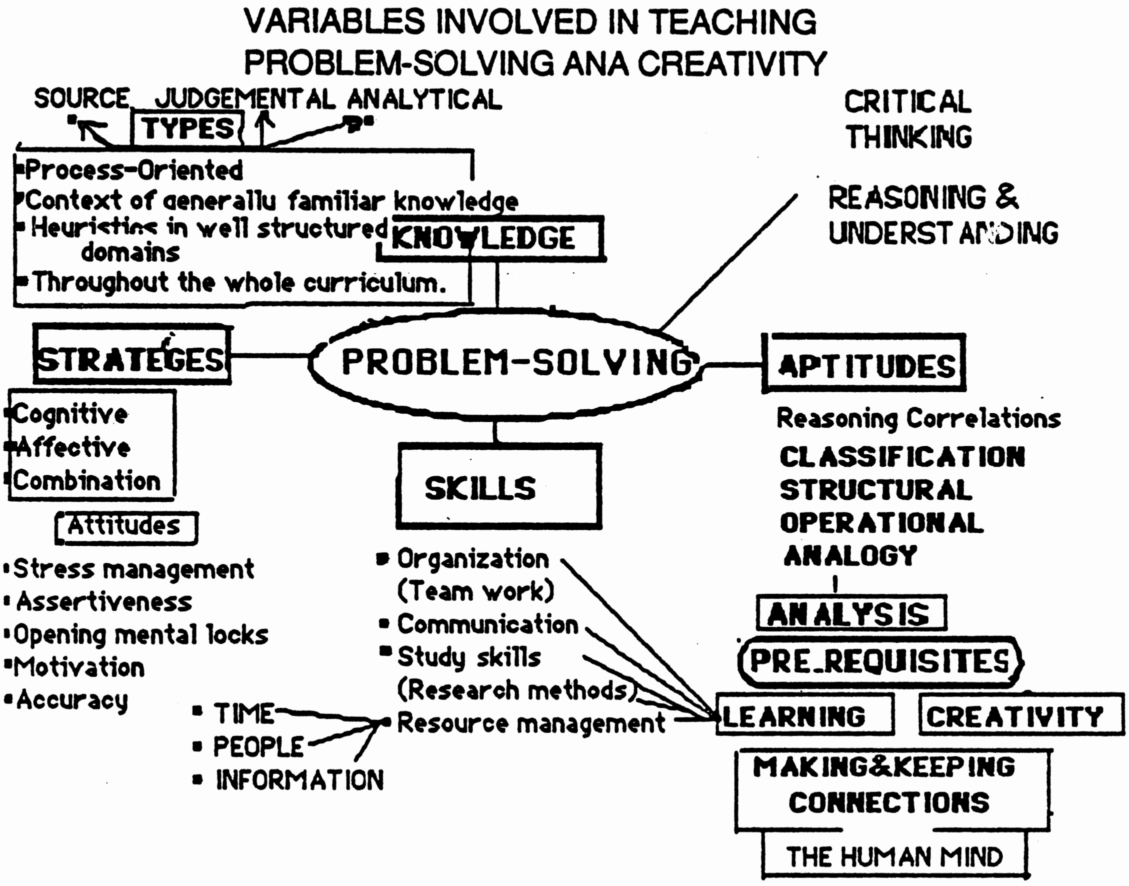
1. Measure the effect of the new problem solving program on the students' knowledge of problem solving procedures (strategy), their acquisition of problem solving skills and their attitudes and aptitudes towards problem solving and creativity

2. Compare the results with those obtained from the evaluation of the other North American Programs during 1987/88 (c.f. Assaad 1988).

3 Compare the results with Champlain program results obtained during the1986/87 research project.(Assaad 1987)

DIAGRAM 1

VARIABLES INVOLVED IN TEACHING PROBLEM SOLVING AND CREATIVITY



4. Measure the effect of the new, optimized creative problem solving course on the students' performance in other courses of a problem solving nature. This will be done by comparing a student's average in problem solving oriented courses from previous semesters with their overall perforfmance during the semester in which they were enrolled in Problem Solving courses. This will clarify to what extent the new creative problem solving course overcomes the student's difficulty in transferring what has been learned to other courses and situations.

5 Compare the impact of creative problem solving courses on students' learning, performance and class averages.

6 Determine the impact of the various C.P.S. course components on students.

METHODOLOGY

The Research Design

This research project will study the relationship between the independent variable "studying the new problem solving course" and the dependent variables of problem solving knowledge, strategies, skills, attitudes, aptitudes and creativity.

DESIGN OF PROOF

The basic research design studies the effect of teaching using the new course. A comparision of the measures of knowledge, strategies, skills, attitudes, aptitudes and creativity are taken before and after the treatment

The basic design is illustrated in diagram No. 2.

DIAGRAM No. 2

DESIGN OF PROOF

	Independent Variables	Dependent Variables
	I.THE NEW COURSE	
	II.NORTH AMERICAN PROG.	
	1.CRM Multimedia	Content variables
		- P.S. Knowledge
Social background	2.Rubinstein's Pattern	- P.S. Strategies
	in Problem Solving	- P.S. Skills
		- P.S. Attitudes
	3.Reid's Applied	- P.S. Aptitudes
	Problem Solving	CREATIVITY
	III. CHAMPLAIN SYSTEM	PROCESS AND
	C.P.S,CPSW & CoRT Thinking	EXPERIENTIAL
		VARIABLES
	Control	
	Group 1,2	VARIABLES

VALIDITY

The only threats to internal validity in this study are testing and instrumentation on the one hand, and coding reliability for open-ended questions on the other. Testing is a threat when a subject is exposed to a particular test more than once. For instance, performance may be altered because the student remembers some of the questions or finds the repitition of testing boring and becomes careless as a result. Changing testing instruments may actually create the instrumentation problem since it may be the cause of altering student performance.

To increase the internal validity, the measuring instruments used in research were examined and pre-tested. The items which show an improvement on the measure because of previous testing were replaced by alternative items or tests. Consequently, the measures of creativity through word hints and the aptitude tests were altered or replaced.

The second threat is related to coding reliability for open-ended questions. This problem occurs when the coder has to categorize the respondents' answers into a limited number of categories, or give the response a score out of 5 or 10. The problem also occurs when the coder has to judge latent structures of thinking or has to make a global judgment about certain traits of the respondent based on comparing two tests of creativity.

To avoid the coding reliability problem in this research, careful construction of the classification system was maintained and careful instructions given to the coders. Their independent judgments were then examined and any differences were discused in order to agree on a final judgment. The advantages of double coding is to provide statistical.

evidence on the reliability of the judgment being made.[2] With regard to "closed" questions with specific answers, apart from clerical errors the coding reliability of this procedure is perfect.

HYPOTHESES

- It is hypothesized that students enrolled in a problem solving course will show greater improvement in the pre- vs post-test measures of problem solving knowledge, problem solving strategies, problem solving skills, attitudes and aptitudes.

- It is hypothesized that students enrolled in creative problem solving course will show greater improvement in the post-test with regard to creativity and innovations index tests as compared to those enrolled in the control group.

- It is likely that at the college level, a cognitive/affective approach is more suitable for developing good problem solving skills.

- It is also hypothesized that students in the problem solving and creativity courses will show a significant improvement in other courses of a problem solving nature. This may lead to an improvement in the overall average for the semester in which they are enrolled, compared to their previous semester's record, and the average of the control sample.

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2 An excellent discussion of the problems of coding can be found in D.P. Cartwright, "Analysis of Qualitative Material", in Fesigner and Katz 1953, Chapter 10

- The Champlain College program in creative problem solving will have greater impact on CEGEP students than other programs.

- Some of the components of the course under study may reveal more impact in specific areas. Other components may not be necessary and could be eliminated.

INSTRUMENTS AND MEASURES

The measuring instruments for this research were selected and designed to test the range of hypotheses relevant to this study. The variables listed below are presented in terms of how they were operationalized and measured.

I **Content Variables:**

Problem solving knowledge, process (procedures), skills, attitudes, creativity and aptitudes.

The nature of the information presented in this course was measured by a modified checklist developed by Kenneth M. Cinnamon and Norman J. Matulef (1979). For this measure, students were asked to rate the importance of each item as it relates to their present need for skill building. The terms included problem awareness, awareness of different types of problems (source, large scale, analytical and judgmental), planning, making connections, study skills and data collection, creativity, analysis (classification, structural analysis, operational analysis) and finally, problem solving processes or procedures.

The checklist also measures the student's knowledge of the problem solving strategies by testing them on the following variables: problem identification, basic problem identification, developing alternatives, evaluation, solution selection, rationalization and implementation.

Problem solving skills were measured by skills perceived and actual skill rating on a five point scale. The variables involved were abilities to recognize, define and classify problems, determine goals, objectives and strategies, manage time, memorize information, think abstractly and think creatively, communicate, analyze, evaluate, rationalize and implement.

ATTITUDES TOWARDS PROBLEM SOLVING AND CREATIVITY

Attitudes, variables and measurements were developed by the researcher using a Likert Measurement scale and also some of the experiential variable measures developed by K. Cinnamon and N. Matulef (see next section). An alternative measure of attitude was the one developed by Bruce Mitchell in his study, *The Measurement of Attitude Change in Creative Problem Solving* (Spring 1981).

CREATIVITY

The instrument used to measure creativity is composed of four tests. These tests were assembled by psychologist, Eugene Raudsepp, co-founder of the Princeton Creativity Research. The choice of these four measurements is based on their suitability to be utilized by classroom teachers in the field. The availability of the four measurements (word hints to creativity, picture test, traits test and personality checklist) gives a variety of means to measure the same phenomenon. An invocation index was also used for comparative purposes.

Each of these tests has proven to be helpful in identifying creativity. The first test "word hints to creativity" is based on the Remote Associates Test developed by Dr. Sarnoff A. Madnick of the University of Michigan and Dr. Sharon Halpern of the University of California at Berkley. Extensive experimentation with this test continues. The sample drawings for the "Picture Test Creativity" are from the Barron-Welsh Art Scale. Several studies regarding this test have shown that creative individuals show a marked preference for the complex asymmetrical drawings. The traits test is based on the Adjective Check List developed by Dr. Harrison G. Gough of the University of California at Berkeley.

Although the tests were not originally developed to assess creativity, it has successfully served to differentiate highly creative individuals from the less creative. For example, a study of writers, mathematicians, architects, research scientists, and engineers conducted by Dr. Donald W. MacKinnon of the Institute of Personality Assessment and Research showed that the adjectives checked by creative individuals reflects an excellent self-image. Yet, paradoxically, the same subjects also checked more unfavorable adjectives than did their less creative colleagues. In Dr. MacKinnon's words: "One finds in these contrasting emphases in self-description a hint of one of the most salient characteristics of the creative person, namely his courage". The refrence here is not to physical courage, though a highly creative person may have courage of this kind but rather to personal courage of the mind that often makes a person stand aside from society and in conflict with it. "It is the courage to be oneself in the fullest sense, to grow in great measure into the person one is capable of becoming".

The items of personality checklist are based on several questionnaires used in creativity studies, including the Myers-Briggs Type Indicator, the Cree Questionnaires, California Psychological Inventory and others. The test has proven helpful in identifying creative individuals who tend to score highest on the theoretical and aesthetic scales and lower than average on the political, economic, social, and religious scales.[3]

APTITUDE VARIABLES

Aptitude variables in this study are: reasoning, operational analysis, classification (figure classification), analogies and comprehension. These studies were measured by tests developed by the author and adapted from the IBM, Univac, Honeywell and NCR aptitude tests.

II Process and Experiential Variables:

Measuring the effectiveness of the structuring format for the three courses under study was accomplished through two feedback questionnaires completed at the end of the course.

Participant observation consisted of monitoring and recording such things as body language, vocal patterns and seating arrangements. The following variables

[3] The above are Mr. Randsepp's comments on his sample tests (Cinnamon 1979, 114-115).

were accounted for:

CONTENT:

1. The extent to which the student understood the information presented.
2. The extent to which the student agreed with the information presented.
3. The extent to which the student valued the information presented.

PROCESS:

4. The degree to which the course met the needs of the class.
5. The degree of openness, spontaneity, humor and energy exhibited by the instructor.
6. The degree to which the instructor encouraged group cohesiveness, trust, and responsiveness.

EXPERIENCE:

7. The amount of learning the student experienced in this course.
8. The extent of enjoyment the student experienced in this course.
9. The extent to which the course was relevant to student life.

SUBJECTS

The experimental groups were composed of two groups enrolled during the 1988/89 academic year in two sections of the new proposed course, section A(N=30) and section B (N=27). The total sample consisted of 57 students. The control group consisted of 68 students registered in comparable courses: International Politics (N=35) Humanities (N=33) and labelled Control Group 1 (International Politics) and Control Group 2 respectively.

PROCEDURE

The pre-tests, including the formentioned batteries, were administered to the experimental groups on the first day of class. The new proposed course was taught throughout the semester and during the final two weeks of classes, all subjects completed a modified post-test.

RESULTS

Problem Solving Knowledge

This section deals with the extent to which students can understand and differentiate between the various types of problems such as source or large-scale, judgemental and analytical (logical or textbook). Problem solving knowledge also includes awareness of problem solving requirements: learning (planning, making connections and study skills), analysis (classification, structural and operational) and creativity.

The data in Table No. 1 indicates significant differences on the problem solving knowledge score between those who studied problem solving (the experimental groups) and those who did not (the control groups). Course comparisions of pre- vs post-scores yielded higher results for the experimental groups. As for the new course, CPS Section A, 76.7 % of the students in their pre-test received a score below 60%. While 70% were able to gain a score above 60% on their post-test. Only 6.7% were not able to develop adequate problem solving knowledge and remained below 60%. Classifying those who pass, the data shows that 20% were able to earn a score between 91-100%; 30% obtained a score between 81-90% and 40% obtianed a score between 71-79%. The same pattern was revealed for Section B and for the total sample which contributed results for both sections. The Gamma Correlation varied from between 0.15 to 0.2, and Pearsons'R between 0.10 to 0.20 with a level of significance which varies between 0.16 to 0.29
(see Table No. 1).

TABLE No. 1

Problem Solving Knowledge measured by P.S. Checklist

Results by course	CPS A		CPS B		Total Sample		Control 1		Control 2	
PS.Knowledge	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %
91-100	0	20.0	0	14.8	0	17.5	0	0	0	0
81-90	3.3	30.0	0	11.1	1.8	21.1	0	0	0	3
71-79	10.0	40.0	7.4	48.1	8.8	43.9	5.9	5.9	6.1	6.1
60-70	10.0	3.3	33.3	22.2	21.1	12.3	0	11.8	18.2	21.0
0-59	76.7	6.7	59.3	3.7	68.4	5.3	91.1	82.4	75.8	69.0
N	33		27		57		34		33	
Gamma	.15		.25		.10		.58		1.00	
Pearsons'R	.10		.20		.13		.12		.91	
Significance	.29		.16		.17		.24		0.00	

Measuring problem solving knowledge by course examinations revealed more valid correlations. For example Gamma for Section A measuring the correlation between midterm and final exam was 0.61and Pearsons'R was .54 (Sig. 0.001). Section B meanwhile, showed an even higher correlations with Gamma at.99, and Pearsons'R at 83 (Sig. 00.00). The correlation for the total sample was Gamma .80, Pearsons'R .69 (Sig. 0.00).

The problem solving knowledge components correlation of the pre- vs the post-test for the different variable involved in measuring problem solving knoweldge revealed valid correlations measured by Gamma. Table No.1.1 reports the results.

TABLE NO 1.1

Correlations of Problem Solving Components Pre- vs Post Measured by Gamma For the Total Sample of the New Proposed Course

P.S. COMPONENT	Gamma	Pearsons'R	Significance
Problem Awareness	0.34	0.20	0.07
Ability to Differentiate between PS types	0.22	0.13	0.17
Awareness of General Requirements	0.07	0.03	0.42
Learning-Gerneral	0.57	0.34	0.005
Planning Knowledge	0.41	0.25	0.03
Making and Keeping Connections	0.48	0.33	0.007
Study Skills	0.36	0.22	0.05
Creativity	0.19	0.16	0.23
Analysis	0.40	0.16	0.11
Classification	0.28	0.13	0.16
Structural Analysis	0.70	0.23	0.05
Operational Analysis	0.01	0.005	0.49
Problem Solving Process	0.56	0.27	0.02
Problem Identification	0.37	0.20	0.07
Developing Alternative	0.08	0.68	0.27
Evaluation	0.02	0.004	0.49
Selection	0.39	0.23	0.04
Relationship and Implementation	0.83	0.39	0.001

Students taking the new proposed course developed a high level of problem awareness

(Gamma 0.34, Pearsons'R 0.20, Sig. 0.07), ability to classify problems and differentiate among the different types in terms of source problem, judgement problems and analytical (Gamma 0.22, Pearsons'R 0.13, Sig. 0.17). Although students were not able to master the knowledge related to the requirements in general (Gamma 0.07, Pearsons'R 0.30, Sig. 0.42), they were able to understand each requirement independently; the correlation for learning was Gamma 0.57, Pearsons'R 0.34, Sig. .005. They developed knowledge of planning (Gamma 0.41,Pearsons'R 0.25, Sig. 0.03), making connections (Gamma 0.48, Pearsons'R 0.33, Sig. .007) and study skills (Gamma 0.36, Pearsons'R 0.22, Sig. 0.05). Students also acquired greater knowledge of what constitutes creativity , what the mental blocks for creative thinking are and how ther can be overcome. This is not a measure of how creativity was developed but simply their knowledge regarding the concept (Gamma 0.19, Pearsons'R 0.10, Sig 0.23).

Students also developed their understanding of analysis and its various types, particularly classification and structural analysis. (Gamma for classification was 0.28, Pearsons'R 0.13, Sig. 0.16; Gamma for structural analysis was -0.70, Pearsons'R -0.23, Sig. 0.05.) As for operational analysis, students had difficulty mastering the concept. (Gamma was weak 0.01, Pearsons'R .005, Sig. 0.49.) They did, however increase their knowledge of the problem solving process and procedures. (Gamma 0.56, Pearsons'R 0.27, Sig. 0.02.)

In sum the proposed course revealed development in all problem solving knowledge variables except the requirement in general and operational analysis. Therefore, teaching a problem solving course is extremely useful in developing problem solving knowledge.

In comparison with the other North American courses evaluated at the CEGEP level, CPSW (Gamma 1.00), CPS (Gamma 0.79) and Rubinstein's Patterns of Problem Solving (Gamma 0.68) had the highest scores followed by CRM Multimedia (Gamma 0.33), the new proposed course, section B (Gamma 0.25) Reid's Applied Problem Solving Through Creative Thinking (Gamma 0.22), and finally the new proposed course, section A (Gamma 0.15).

Although the new proposed course ranked behind other courses on problem solving knowledge, the results show that this rank was balanced by its ability to develope other variables such as skills, attitudes, creativity and aptitudes. This reflects the need to compromise in problem solving knowledge if the course objective includes other variables. If the main objective is to develop knowledge, at this point, one would choose CPSW, CPS or Rubinstien patterns in Problem Solving (see Table No. 2). (For percentages see Table 3.)

TABLE No 2

The impact of programs in developing problem solving knowledge measured by Gamma and Pearson's R

CORRELATION Nature of program	GAMMA	PEARSON'S R	SIGNIFICANCE
I <u>Process-oriented</u>			
1. C.P.S.	0.79	0.39	0.009
2. CPSW	1.00	0.31	0.050
3. C.R.M. Multi Media	0.33	0.34	0.030
II <u>General familiar knowledge</u>			
4. De Bono's CORT	0.31	0.08	0.320
III <u>Heuristics in a well-structured Domain</u>			
5. Rubinstein	0.68	0.46	0.002
IV <u>Combination</u>			
6. Reid	0.22	0.25	0.090
V <u>New Proposed Course</u>			
7. CPS.A	0.00	0.00	0.00
8. CPS.B	0.00	0.00	0.00
9. Total S	0.00	0.00	0.00
Control Sample 1	0.58	0.12	0.240
Control Sample 2	1.00	0.91	0.000

TABLE No 3

Problem Solving Knowledge measured by P.S. Checklist

Results by course	CRM		De Bono		Rubin		Ried	
PS.Know-ledge Sco	Pre	Post	Pre	Post	Pre	Post	Pre	Post
91-100	0	0	0	8.8	0	5.4	0	3.3
81-90	3.3	16.7	0	11.8	2.7	10.8	3.3	20.0
70-80	10.0	33	2.9	14.7	5.4	27.0	20.0	23.3
61-70	6.7	26.7	8.8	29.4	18.9	24.3	10.0	40.0
0-59	80.0	53.3	88.2	35.3	73.0	32.4	66.7	13.3
N	(N=30)		(N=31)		(N=37)		(N=30)	
Gamma	0.33		0.31		0.68		0.22	
Pearson'sR	0.34		0.08		0.46		0.25	
Significanc	0.03		0.32		0.002		0.09	

TABLE No.3 con.

Problem Solving Knowledge measured by P.S. Checklist for CPS & CPSW COURSES

Results by course	CPS		CPSW		Control 1		Control 2	
PS.Knowledge Sco	Pre	Post	Pre	Post	Pre	Post	Pre	Post
91-100	0	2.7	0	8.2	0	0	0	0
81-90	0	13.5	0	23.5	0	0	0	3
71-80	2.7	27.0	0	8.8	5.9	5.9	6.1	6.1
61-70	10.8	35.1	2.9	14.7	0	11.8	18.2	21.2
0-59	86.0	21.6	97.1	44.1	91.1	82.4	75.8	69.7
	(N=37)		(N=34)		(N=34)		(N=33)	
Gamma	0.79		1.00		.58		1.00	
Pearsons'R	0.39		0.31		.12		.91	
Significance	.009		.05		.24		00	

Problem Solving Strategies

Creative problem-solving models describe a series of stages, phases or steps which must be followed in order to arrive at a solution (Guilford, 1975; Osborn, 1963; Koestler, 1971). Although each model uses a different set of labels to present its sequence of problem-solving stages (strategies), there appears to be an underlying commonality in the process and goals of each stage.

The general problem-solving strategies (stages) can be identified as follows:

1. **Problem identification or problem definition:** Nezu and D'Zurilla (1981a) assessed the "contribution" of the problem definition stage on the generation of alternatives and decision making stages. Subjects provided with detailed instructions in problem definition chose significantly more effective solutions than persons without guidelines for problem definition (Nezu and D'Zurilla, 1981a). Also, training in problem definition enhanced the generation of the alternatives stage of problem solving by increasing the ability of subjects to produce high quality solution alternatives (Nezu and D'Zurilla, 1981a).

2. **Developing alternatives:** The two main principles associated with this step are; strategy-tactics principle and the deferment of judgement principle. It is proven that the production of a greater number of alternatives (probable solutions) and an initial deferment of judgement about each alternative results in the discovery of higher quality solutions and increases one's chance of selecting the best solution (Nezu and D'Zurilla, 1980).

3. **Evaluation:** In another study, Nezu and D'Zurilla (1979) found that a group which received comprehensive instruction in specific criteria for evaluating

consequences of a solution compared with a group given only the utility rule.[4]

4. **Decision or Selection of alternatives:** It was found out that training in decision making significantly increased decision making effectiveness. (Nezu and D'Zurilla, 1981b).

5. **Rationalization and implementation:** This stage was evaluated as a "verification of problem solution." (Cormier, Otani and Cormier, 1986:96.) It was concluded that, training was significantly effective (Cormier et al., 1986).

The present study attempts to assess the effects of the different post-secondary programs and courses under consideration including the new proposed course according to the problem solving strategies or stages named above. Table 3 presents the percentages of students performance on the pre-test and post-test for the nine groups under study. Gamma and Pearsons'R was perfromed to measure the correlation and the level of significance. The new proposed course ranked second after Reid's Applied Problem Solving.

Therefore, Reid's was the best program for improving students' problem solving strategy (Gamma .63) followed by the new proposed course (Gamma for Section A 0.56, B 0.49 and total sample 0.59), and theirby the CRM Multimedia program (Gamma .46). Rubinstein's Pattern of Problem Solving meanwhile, did not do very well in relation to developing strategies (Gamma .19), and ranked behind De Bono's CORT Thinking (Gamma

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[4]The utility rule is defined as a course of action that will alter a problem situation so that it is no longer a problem "while maximizing positive consequences and minimizing negative consequences, long-term as well as short-term, and social as well as personal consequences."

.30). Assaad's CPS, early version,which was evaluated in 1986, (Gamma .36) surpassed De Bono's CORT Thinking and Rubinstein's Pattern of Problem Solving, but ranked behind Reid's Applied Problem Solving Through Creative Thinking program, the new CPS version, CRM Multimedia. CPSW (Gamma .24) was just ahead of Rubinstein's Pattern of Problem Solving. Clearly the optimum program dealing with P.S. strategies should rely on Reid's Applied Problem Solving Through Creative Thinking or the new proposed course. In general the process-oriented programs are better for developing P.S. strategies than heuristics or programs of general familiar knowledge. It is important to note here that the new proposed course and Reid's Applied Problem Solving Through Creative Thinking combines both types of programs (See Table No.4).

TABLE NO. 4

PROBLEM SOLVING STRATEGY BY PROGRAM

RESULT		HIGH %	AVERAGE %	LOW %	GAMMA	PEARSONS' R	SIGNIFICANCE
Nature of program							
I Process-oriented							
1. CPS	pre	5.5	42.2	51.4	.36	.18	.14
	post	27.0	56.8	16.2			
2. CPSW	pre	0.0	35.3	64.7	.24	.11	.27
	post	29.0	44.1	16.4			
3. CRM	pre	0.0	23.3	76.7	.46	.25	.09
	post	10.0	33.3	50.0			
II General Familiar Knowledge							
4. CORT	pre	0.0	23.3	76.7	.46	.25	.09
	post	11.0	55.9	32.4			

III Heuristics in a well-structured domain								
5. Rubinstein	pre	2.7	27.0	70.3	.19	.014	.47
	post	13.5	29.7	51.4			
IV Combination							
6. Reid	pre	0.0	16.7	83.3	.63	.37	.02
	post	16.7	50.0	33.3			
V New Proposed course							
7 CPS A	**pre**	**00**	**23.3**	**76.7**	**.56**	**.32**	**.04**
	post	**13.3**	**70.0**	**16.7**			
8 CPC B	**pre**	**00**	**25.9**	**74.0**	**.49**	**.21**	**.14**
	post	**14.8**	**63.0**	**22.2**			
9 Total Sample	**pre**	**00**	**24.6**	**75.4**	**.59**	**.26**	**.02**
	post	**14**	**66.7**	**19.3**			
10 Control 1	pre	0.0	8.6	91.4	.08	.01	.47
	post	0.0	20.6	97.5			
11 Control 2	pre	0.0	34.4	65.6	-.03	-.12	.25
	post	0.0	43.8	56.3			

As for each program 's ability to develope the various problem solving steps, Reid's Applied Problem Solving Through Creative Thinking ranked first. It contributed significantly to all the steps, especially problem identification (Gamma .86), evaluation, rationalization and implementation (Gamma 1.0). The new course ranked second, contributing to all stepsand not notably problem identification (Gamma 0.32 and 43), selection of alternatives (decisions) (0.61 and 0.24) and rationalizaiton and implementation (0.69 and 0.92). Rubinstein's Pattern of Problem Solving and CRM Multimedia ranked third. In comparison with the new course, it was ahead in two steps and behind in three steps.

In considering each step sep separately, **problem identification** was best developed by Reid's Applied Problem Solving Through Creative Thinking (Gamma .86), followed by the new course (Gamma 0.32 and 43) then by Rubinstein's Pattern of Problem Solving (Gamma .37) and CRM Multimedia (Gamma .17). **Developing alternatives** was best developed by Rubinstein's Pattern of Problem Solving (Gamma .39), followed by the new course Section A (0.55) then CRM Multimedia (Gamma .33) and CORT Thinking (Gamma .30). **Evaluation** was developed best by Reid's program **creative thinking** (Gamma1.0), followed by CRM Multimedia (Gamma .24), and CPSW (Gamma .19). **Selection of alternatives** was developed best by CRM Multimedia (Gamma .70) followed by CORT Thinking (Gamma .62), the new course Section A (Gamma 0.61) and Rubinstein's Pattern of Problem Solving (Gamma .44). Finally, **rationalization and implementation** were developed best by Reid's Applied

Problem Solving Through Creative Thinking (Gamma 1.0), followed by the new course Section B (Gamma 0.92, total sample 0.83 and Section A 0.69) and Rubinstein's Pattern of Problem Solving (Gamma .50) and CPS (Gamma .38) (See Table No.5). On this basis, the courses under study each contributed significantly, with minor variations, to problem solving steps. Once again, developing the course dependended on a combination of the different programs, with special consideration given to Reid's The results suggest that greater effort is needed to improve **problem identification and developing alternative solutions.**

TABLE NO. 5

Steps in Problem Solving by Program Measured by Gamma

P.S. Steps	Problem Identification	Developing Alternatives	Evaluation	Selection of Alternatives	Ration-alization
PROGRAM					
I Precess-oriented					
1. C.P.S.	-.06	.04	-.23	.27	. 38
2. CPSW	-.02	.23	.19	.28	-.11
3. C.R.M.	. 17	.33	.24	.70	.17
4. Multi Media					
II General familiar knowledge					
5. De Bono's CORT	.16	.30	-.11	.62	.28
III Heuristics in a well-structured Domain					
6. Rubinstein	.37	.39	.15	.44	.50

IV Combination					
7. Reid	.86	.15	1.0	.31	1.0
V New Proposed Course					
8. CPS A	**.32**	**.11**	**.55**	**.61**	**.69**
9. CPS B	**.43**	**.05**	**-1.0**	**.24**	**.92**
10. Total Sample	**.37**	**.08**	**.02**	**.39**	**.83**
11. Control Sample 1	-.26	.16	.27	.11	.82
12. Control Sample 2	.18	.40	.08	.41	.57

Several implicatons can be drown from the evaluation of problem solving strategies (steps) among different North American programs and from the attempt to integrate them in a new course. First, the results support the usefulness of the five-stage problem solving model. Second, training CEGEP students on all stages increased their problem solving skills. Third, the new proposed course as well as Reid's program proved valauable in teaching all five stages. Fourth, some programs developed certain stages better than others. Fifth, the course to be implemented should be a function of the designer's objectives.

ATTITUDES

The purpose of this section is to determine whether the new proposed courses in creative problem solving affect attitudes in creative problem solving. One of the true values of CPS courses is their influence on attitudes of participants. A number of studies in 7th and 12th grade students show that special problem solving workshops and in-service sessions have produced positive changes in creative thinking (Clark & Trowbridge 1971; Mansfield 1979). Studies conducted on college students and hospital personnel in the USA also yielded similar results (Glover 1976; Burstinger 1975).

Kraut (1976) proposed a training model that involved a causal chain of attitudes influencing behavior & leading to improved results. Rickards (1975) reported a field experiment in which results using creative problem-solving techniques based on divergent thinking were no better than results using conventional techniques. Rickards attributed the lack of success to an inability of the experimental participants to change their attitudes toward divergent thinking and concluded that such attitudes may be very difficult to change until adequate procedures are found to transform long-held suspicious towards divergent thinking against its basic principles. In contrast, Basadur, Graen, and Green (1982) found that improvements in attitudes toward divergent thinking accompanied increases in creative performance after appropriate training. The training provided by Basadur et al. (1982) was more intensive than that used in the Rickards (1975) study, and was based on a comprehensive process of creative problem solving. Basadur and Finkbeiner (1985) offered a model describing how attitudinal processes may enhance cognitive processes of divergence in creative problem solving.

Although research indicates that training creative problem solving with divergent thinking is useful, chsnges in behavior in the work place are unlikely to occur unless positive attitudes toward divergent thinking are built up job (Basadur et al., 1982). Indeed, evidence suggests that many people who work in organizations have negative attitudes toward creativity, divergent thinking and new ideas (Rickards, 1980; Shore, 1980). Moreover, Kirton (1976) found that people in organizations who have more innovative styles and are more divergent in their thinking incur more negative attitudes and mistrust from others. They encounter greater difficulty in getting their ideas accepted because they tend to propose more unusual solutions and may even redefine given problems in unexpected ways. Others in the organization tend to have negative attitudes toward such divergent approaches inasmuch as the substantial changes they represent evoke feelings of discomfort and apprehension. Unless improvements in these attitudes toward divergent thinking can be achieved, training efforts in the techniques of problem solving based on divergent thinking may be fruitless. Attitudes of manufacturing engineers tend to be especially negative toward any form of divergent thinking and creative problem solving. They tend to see no place for creativity in their structured, implementation-oriented environment where practicality is so highly valued. There is evidence that engineering training itself contributes to reducing the value of divergent thinking (Altemeyer, 1966; Doktor, 1970).

Changing attitudes of any kind is not an easy task. As noted by McGuire (1969), perhaps no area of research in social psychology has been as active as the formation and change of attitudes. Much theoretical and empirical work has been devoted to the study of the persuasion process through which attitudes can be changed. One approach is the cognitive response approach to the study of persuasion (Petty & Cacioppo, 1981). This approach postulates that attitude-change processes can best be understood by taking into account the thoughts that arise in the persuasion situation. To the extent that the persuasion situation elicits thoughts that are favorable, attitude change in the direction advocated should be facilitated. However, if negative thoughts are elicited, attitude change should be inhibited. Based on this theoretical framework, a person's thoughts during a persuasion attempt regarding a given topic appear to be related to the change that takes place in the attitudes toward the object of the persuasion.

In the current study, we attempted to determine the extent to which the new proposed course was able to effect changes in the attitudes of CEGEP students towards problem solving and creativity (the subject matter and the problem solving course). Results revealed that the new proposed course produced significant change in modifying students' attitudes towards both the subject matter (Gamma was .44 for Section A, ,70 for Section B and .57 for the total sample) and problem solving courses themselves (Gamma was .67 for Section A, .52 for Section B, and .61 for total sample). See Table No. 6.

TABLE No. 6

ATTITUDES TOWARDS PROBLEM SOLVING BY PROGRAM MEASURED BY GAMMA AND PEARSONS'R

CORRELATION PROGRAMS	SUBJECT MATTER Gamma	Pearson's R	Significance	P.S. COURSES Gamma	Pearson's R	Significance
I Process-oriented						
1. CPS	.33	.28	.05	-.0003	-.09	.31
2. CPSW	.12	.06	.36	.30	.23	.09
3. CRM	.44	.41	.01	.32	-.05	.40
II General Familiar Knowledge						
4. CORT	.68	.57	.0002	.41	.26	.07
III Heuristics in a well-structured domain						
5. Rubinstein	.14	.04	.40	-.30	-.29	.04
IV Combination						
6. Reid	.59	.33	.04	.40	.28	.07
V.New Proposed Course						
7.CPS A	**.44**	**.31**	**.05**	**.67**	**.52**	**.002**
8.CPS B	**.70**	**.62**	**.0003**	**.52**	**.34**	**.04**
9.Total Sample	**.57**	**.43**	**.0004**	**.61**	**.44**	**.0003**
10 Control 1	.46	.45	.004	.33	.28	.05
11. Control 2	.08	.18	.15	.01	.10	.29

Comparison with other North American post-secondary courses and programs revealed that the new proposed program ranked first for changing attitudes towards problem solving courses. As for the subject matter it falls behind De Bono's CORT Thinking (Gamma .68) and Reid's Applied Problem Solving Through Creative Thinking (Gamma .59). This means that process oriented programs have more impact on changing attitudes towards problem solving courses. However, programs within general familiar knowledge have more impact on changing attitudes towards the subject matter (see Table No. 6.1).

TABLE No. 6.1
CORRELATION PRE VS. POST IN INTEREST IN PROBLEM SOLVING MEASURED BY GAMMA AND PEARSONS'R FOR THE NEW PROPOSED COURSE

COURSE	Gamma	Pearsons'R	Significance
CPS A	.12	.07	.36
CPS B	.06	.01	.48
Total Sample	.20	.10	.23

Therefore, the best attitudinal results were obtained from a combined approach such as the one used for the new proposed course and Reid's Applied Problem Solving Through Creative Thinking program. The more general the problems adopted, the more positive the attitudes. Probability and mathematical problems were hard to comprehend for CEGEP students and contributed to negative attitudes toward problem solving courses as in the case of Rubinstein's Pattern of Problem Solving course.

SKILLS

Perceived need for developing problem solving skills was measured by 10 items related to the following variables: abilities to recognize problems; define and classify problems; determine goals, objectives and strategies; manage time; memorize information; think abstractly; think creatively; communicate, analyze, evaluate, rationalize and implement the solution.

The skill need index is the sum of the 10 items. The result of the newly developed course revealed decrease in the skill need index as a consequence of taking problem solving course for Section A and an increase for Section B.

Therfore, one can conclude that perceived skill need index varies due to other factors. Some students after taking the course felt that the course fulfilled their need, while, others felt that they needed more skills. This depends on the students' perception of the skills involved before taking the course. As such, taking problem solving courses increases or decreases students' awareness of the need depending on whether or not they underestimate their need before taking the course.

Comparing the courses involved in the experiment, the results revealed an increase in the skill needed index in all courses except Rubinstien.

TABLE No.7

PERCEIVED SKILL NEED INDEX AND P.S. PROGRAMS MEASURED BY GAMMA AND PEARSON'S

CORRELATION PROGRAMS	Gamma	Pearson's R	Significance
I Process-oriented			
1. CPS	.17	.08	.32
2. CPSW	.52	.28	.05
3. CRM	.34	.27	.08
II General Familiar Knowledge			
4. CORT	.33	.24	.09
III Heuristics in a well-structured domain			
5. Rubinstein	.07	-.03	.42
IV Combination			
6. Reid	.62	.34	.03
.V.New Proposed Course			
7. CPS A	.16	.09	.31
8 CPS B	.61	.47	.007
9. Total Sample	.48	.33	.006
10.. Control 1	-.06	-.06	.38
11.. Control 2	-.04	-.04	.39

CREATIVITY

Teaching people to think creatively and measuring creativity is a controversial issue. In this study, creativity is defined as the ability to think more creatively by making students aware of the mental blocks which hinder creative thinking. Creativity in this study is measured not only by assessing it from test results, but also by assessing traits and creative personality (cf. Haefile:195-207). Results of five tests of creativity revealed that the best program in the development of creativity was CRM Multimedia. It obtained a higher correlation in each of the five tests (Gamma .55, .52, .69, .87 and .52). The new proposed course, Section B, ranked second (Gamma .76, .45, .95, .62, .41). The total sample for the new proposed course ranked third (Gamma .60, .42, .85, .52, .47). Rubinstein's Pattern of Problem Solving program ranked fourth (Gamma .50, ..56, .77, .57), except the traits test (Gamma .11). Reid's Applied Problem Solving Through Creative Thinking ranked fifth (Gamma .42, .74, .88, .46), except the personality checklist (Gamma .31). The new proposed course,Section A, ranked sixth followed by CORT Thinking. CPSW ranked eighth and CPS was nineth. As for the impact of the different types of programs in developing creativity, the data revealed no differences. Whatever the nature of the course-process-oriented, general familiar knowledge or heuristic-creativity does develop. Courses which emphasize the elimination of mental blocks through various steps revealed better results in developing creativity. (See Table No. 8).

TABLE No. 8
CREATIVITY BY P.S PROGRAMS MEASURED BY GAMMA.

CREATIVITY TESTS / PROGRAMS	Words Hints To Creativity	Picture Test	Traits Test	Personality Check List	Innovation Index
I Process-oriented					
1. CPS	.29	.65	.60	.38	-.04
2. CPSW	.30	.57	.67	.35	.30
3. CRM	.55	.52	.69	.87	.52
II General Familiar Knowledge					
4. CORT	.45	.58	.25	.52	.26
III Heuristics in a well-structured domain					
5. Rubinstein	.50	.56	.11	.77	.57
IV Combination					
6. Reid	.42	.74	.88	.31	.46
V.New Proposed Course					
7. CPS A	**.52**	**.05**	**.68**	**.40**	**.54**
8. CPS B	**.70**	**.45**	**.95**	**.62**	**.41**
9. Total Sample	**.60**	**.42**	**.85**	**.52**	**.47**
10.Control 1	.33	-.03	.13	-.04	.29
11.Control 2	.35	.10	.27	.40	.26

TABLE NO. 8 CON.
RANK ORDER CREATIVITY FOR EACH PROGRAM

						Rank Order Score	
CPS	1	8	3	3	1	16	I
CPSW	2	6	4	2	3	17	H
CRM	7	4	6	8	7	32	A
CORT	4	7	2	5	2	20	G
Rubinstein	5	5	1	7	9	27	D
Reid	3	9	8	1	5	26	E
Section A	6	1	5	4	8	24	F
Section B	9	3	9	6	4	31	B
Total Sample	8	2	7	5	6	28	C

No	73.5	58.8	41
No.	2.9	2.9	5.8

APTITUDES

The data revealed that the newly developed course ranked first in developing aptitudes. When the results for Section A are correllated for pre- vs post-test according to five different measures of aptitudes we get the following figures: Gamma .91, .54, .82, .91, .53. With regard to Section B, the results were: Gamma 1.00, .55, 1.00, .81, .60. Total sample correlations were: Gamma .96, .54, .79, .85, .58.

Comparing the newly developed course with the other programs evaluated during the year 1987-88, reveals that Rubinstein ranked second after the newly developed course. Reid's Applied Problem Solving Through Creative Thinking program ranked third in developing aptitudes, followed by De Bono's CORT Thinking, CRM Multimedia, CPSW and CPS. Considering each aptitude separately, the newly developed course-Section B, has the highest impact on **reasoning** (Gamma 1.00), followed by the total sample (Gamma .96) and CPSA (Gamma .91). As for **operational analysis** (number series), De Bono's CORT Thinking ranked first (Gamma .66), followed by Rubinstein's Pattern of Problem Solving (Gamma .65). The newly developed course ranked third (Gamma .55 to .54) in **figure classification** either negatively or positively with the following results. The newly developed course CPS B ranked first with (Gamma 1.00), followed by Rubinstein (Gamma .88). Section A and total sample came next (Gamma .82 and .79); other programs followed. For **verbal analogies,** Rubinstein's Pattern of Problem Solving ranked first (Gamma 1.00), followed by the newly developed courses (Gamma .91, .85 and .81), CRM Multimedia (Gamma .88), Reid's Applied Problem Solving Through Creative Thinking (Gamma .62) and CPS (Gamma .21). The only three courses which contributed to comprehension were the newly developed course (Gamma .60, .58, ..53), followed by Reid's Applied Problem Solving Through Creative Thinking

TABLE No. 8.1
CREATIVITY AS INDICATED BY THE CODERS JUDGMENT BY PROGRAM IN PERCENTAGE

CREATIVITY TESTS PROGRAMES		Picture Tests%	Traits Tests %	Personality Tests %
I Process-Oriented Programes				
1. CPS	Yes	48.6	40.5	54.1
	No	40.5	48.6	32.4
		18.8	10.8	13.5
2. CPSW	Yes	47.1	70.6	55.9
	No	44.5	20.6	35.3
		8.8	8.8	8.8
3. CRM	Yes	30.0	43.3	40.0
	No	63.3	50.0	50.0
		6.7	6.7	10.0
II General Familiar Knowledge				
4. CORT	Yes	47.1	58.8	50.0
	No	41.2	35.3	41.2
		11.7	5.9	8.8
III Heuristics in a well-structured domain				
5. Rubinstein	Yes	48.6	48.6	73.0
	No	45.9	45.9	21.6
		5.4	5.4	5.4
IV Combination				
6. Reid	Yes	90.0	80.0	56.7
	No	10.0	20.0	43.3
V, New Proposed Course				
7.CPS A	**Yes**	**36.7**	**33.3**	**53.3**
	No	**63.3**	**66.7**	**46.7**
8.CPS.B	**Yes**	**51.9**	**29.6**	**48.1**
	No	**48.1**	**70.4**	**51.9**
9.Total Sample	**Yes**	**43.9**	**31.6**	**50.9**
	No	**56.1**	**68.4**	**49.1**
10.Control 1	Yes	24.2	39.4	42.3
	No	55.1	36.4	33.3
		24.2	24.2	24.2
11.Control 2	Yes	23.5	38.2	52.9

(Gamma .47) and CRM Multimedia (Gamma .44). The rest of the programs revealed either minimal or neagtive correlation (see Table No. 9 and 9.1).

TABLE No. 9

APTITIUDES BY PROBLEM SOLVING PROGRAMS MEASURED BY GAMMA.

APTITUDES PROGRAMS	Reasoning	Number Series	Figure Classification	Verbal Analogy	Comprehension
I Process-oriented					
1. CPS	.04	.23	-.04	.38	.21
2. CPSW	..68	.47	.41	.03	-.10
3. CRM	-.03	.38	.52	.88	.44
II . General Familiar Knowledge					
4. CORT	.78	.66	-1.00	.30	.004
III Heuristics in a well-structured domain					
5. Rubinstein	.02	.65	.88	1.00	-1.00
IV Combination					
6. Reid	.84	.37	.63	.62	.47
V.New Proposed Course					
7. CPS A	**.91**	**.54**	**.82**	**.91**	**..53**
8. CPS B	**1.00**	**.55**	**1.00**	**.81**	**.60**
9. Total Sample	**.96**	**.54.**	**.79**	**.85**	**.58**
7. Control 1	.13	.55	-	.13	-.07
8. Control 2	1.00	.14	.18	-.09	-.18

TABLE NO. 9.1
Rank Order Problem Solving Programs According To Their Role In Developing Aptitudes

	Reasoning	Number Series	Figure Classification	Verbal Analogy	Comprehension	Rank Order
1. CPS	3	1	1	3	3	H
2. CPSW	4	4	2	1	1	G
3. CRM	1	3	3	6	4	F
4. CORT	5	8	1	2	2	E
5. Rubinstein	2	7	7	9	1	B
6. Reid	6	2	4	4	5	D
7. CPS A	7	5	6	8	6	A
8. CPS B	9	6	8	5	8	C
9. Total Sample	8	5	5	7	7	A

PROCESS AND EXPERIENTIAL

VARIABLES

In order to be able to evaluate the different problem solving programs and to determine their suitability at the CEGEP level, it is important to consider the way these courses are taught and the students' reaction to them. In this section, therefore, we are concerned with the process and experiential variables. Evaluation is based on the answers to 9 questions divided into three categories.

CONTENT

With regard students' comprehension of the information presented, 56.7% of the class ranked high, 33.3% of the ranked average and only 3.3% ranked low for Section "A" of the new proposed course. The same pattern emerged for Section "B" and for the total sample. These results suggest that the new course is as difficult as Rubinstein's Pattern of Problem Solving, although somewhat easier to understand. Other courses all proved more difficult than the new course. The percentage of students who ranked high in understanding the information presented was between 73.3% and 79.4%. Students tend to agree most with the information presented in the new proposed course, total Sample, (73.3% ranked high), De Bono's CORT Thinking (89.7% ranked high), followed by CPSW (76.7% ranked high), and in Reid's Applied Problem Solving Through Creative Thinking (70.0% ranked high). For Rubinstein's Pattern of Problem Solving and CPS, the percentage which ranked "high" was below 50%. However, students tend to value the information presented in the new proposed course (59.7% ranked high), CPS (73.51), CORT Thinking (66.7), CPSW (56.6) and in Reid's Applied Problem Solving Through Creative Thinking (56.6). Rubinstein's Pattern of Problem Solving and CRM Multimedia ranked second with only 43.2 and 49.9 ranked "high".

THE PROCESS VARIABLES

Of all students enrolled in the new course, 77.2% responded positively to the statement: "The degree to which the course met the needs of the class." All other courses met the needs of the class with the exception of Rubinstein's Pattern of Problem Solving. The percentage of those ranked high in terms of need satisfaction were: Reid's Applied Problem Solving Through Creative Thinking (70%), CORT (70%), CPSW(68.9%), CPS (64.7%) and CRM Multimedia (56.5%). Only 29.7% rated in Rubinstein's program "high" with regard to its need fulfillment No\ major differences are noted with regard to instructor's behavior since all courses are taught by the same instructor. Any minor variations are due to the impact of the audio-visual component of the courses. Students in the new course agreed that the instructor exhibited openness, spontaneity and humor (86.0% ranked high). They also felt that the instructor encouraged group cohesiveness, trust and responsibility (79.0% ranked high).

EXPERIENCE

The amount of learning students experienced was the same for Reid's DeBono's & the CPS & CPSW programs, all of which were rated "high" by approximately 70% of students As for CRM Multimedia, only 56.7% ranked it "high" while 48.6% rated Rubinstein's program in the high categories.

Students most enjoyed Reid's Applied Problem Solving Through Creative Thinking program and CORT Thinking (about 75% ranked "high"), followed by the new course (64% ranked high). They were followed by CPS and CPSW (about 70% ranked high), and finally, Rubinstein's Pattern of Problem Solving and CRM Multimedia (about 50% ranked "high"). There was no major difference among the programs with regard to their relevance to the students' lives. The percentage of students who ranked high for the new proposed course were 65 % for the Total Sample. (See Table No. 10)

TABLE NO. 10-A

PROCESS AND EXPERIENTIAL VARIABLES FOR THE NEWLY DEVELOPED COURSE

CONTENT		CPS A (N=30)	CPS B (N=27)	Total Sample (N=57)
	MV[5]	6.7	3.7	5.3
1. The extent to which I understood the information presented	High 7	3.3	18.5	10.5
	6	16.7	18.5	17.5
	5	36.7	40.7	38.6
	4	33.3	11.1	22.8
	3	0	7.4	3.5
	2	3.3	0	1.8
	Low 1	0	0	0
	MV	6.7	3.7	5.3
2. The extent to which I agreed with the information.	High 7	3.3	11.1	7.0
	6	23.3	46.7	31.6
	5	43.3	25.9	35.1
	4	20.0	14.8	17.5
	3	3.3	3.7	3.5
	2	0	0	0
	Low 1	0	0	0

[5] MV Missing Values

	MV	6.7	3.7	5.3
3. The extent to which I value the information presented.	High 7	6.7	11.1	8.8
	6	20.0	22.2	21.1
	5	26.7	33.3	29.8
	4	23.3	22.2	22.8
	3	13.3	3.7	8.8
	2	3.3	3.7	3.5
	Low 1	0	0	0

PROCESS

	MV	6.7	7.4	7.0
4. The degree to which the course met the needs of the class.	High 7	10.0	11.1	10.5
	6	23.3	40.7	31.6
	5	36.7	33.3	35.1
	4	6.7	3.7	5.3
	3	16.7	0	8.8
	2	0	0	0
	Low 1	0	3.7	1.8
	MV	6.7	7.4	7.0
5. The process of openness, spontaneity, and humor exhibited by the instructor.	High 7	20.0	44.4	31.6
	6	50.0	29.6	40.4
	5	10.0	18.5	14.0
	4	13.3	0	7.0
	3	0	0	0
	2	0	0	0
	Low 1	0	0	0

	MV	6.7	7.4	7.0
6. The degree to which the instructor encouraged group cohesiveness, trust and responsibilities.	High 7	16.7	22.2	19.3
	6	36.7	40.7	38.6
	5	20.0	22.2	21.1
	4	20.0	3.7	12.3
	3	0	3.7	1.8
	2	0	0	0
	Low 1	0	0	0
	MV	6.7	7.4	7.0
7. The amount of learning I experienced.	High 7	10.0	3.7	7.0
	6	20.0	29.6	24.6
	5	33.3	40.7	36.8
	4	13.3	14.8	14.0
	3	10.0	0	5.3
	2	6.7	3.7	5.3
	Low 1	0	0	0
	MV	6.7	7.4	7.0
8. The extent of enjoyment I experienced in this course.	High 7	6.7	22.2	14.0
	6	23.3	29.6	26.3
	5	26.7	22.2	24.6
	4	23.3	11.1	17.5
	3	6.7	3.7	5.3
	2	6.7	0	3.5

	Low 1	0	3.7	1.8
	MV	6.7	7.4	7.0
9. The extent to which the course was relevant to my life.	High 7	13.3	11.1	12.3
	6	30.0	33.3	31.6
	5	20.0	22.2	21.1
	4	10.0	18.5	14.0
	3	16.7	7.4	7.0
	2	13.3	0	7.0
	Low 1	0	0	0

TABLE No. 10-B

PROCESS AND EXPERIENTIAL VARIABLES FOR PROCESS ORIENTED PROGRAMS AND GENERAL FAMILIAR KNOWLEDGE

		Process-oriented			General Familiar Knowledge	Heuristics	
		CPS	CPSW	CRM	CORT	RUBINSTEIN	REID
CONTENT							
	MV[6]			16.7		13.5	10.0
1. The extent to which I understood the information presented.	High 7	5.9	6.7	3.3	6.7	2.710.0	I
	6	29.4	50.0	23.3	33.3	8.1	30.0
	5	44.1	20.0	16.7	33.3	40.5	36.7
	4	17.6	16.7	30.0	23.3	18.9	10.0
	3	0.0	3.3	6.7	3.3	10.8	3.3
	2	2.9	3.3	3.3	0.0	0.0	0.0
	Low 1	0.0	0.0	0.0	0.0	5.4	0.0
	MV			16.7			
2. The extent to which I agreed with the information.	H 7	2.9	6.7	0.0	0.0	0.0	6.7
	6	3.2	36.7	20.0	41.4	13.5	43.3
	5	41.2	33.3	30.0	48.3	32.4	20.0
	4	11.8	10.0	30.0	48.3	27.0	16.7
	3	2.9	10.0	3.3	0.0	10.8	3.3
	2	2.9	3.3	0.0	0.0	0.0	0.0
	L 1	0.0	0.0	0.0	0.0	2.7	0.0
	MV			16.7			
3. The extent to which I valued the information presented.	H 7	0.0	13.3	3.3	3.3	5.4	10.0
	6	29.4	20.0	23.3	36.7	16.2	13.3
	5	44.1	23.3	23.3	26.7	21.6	33.3
	4	14.7	16.7	16.7	30.0	24.3	30.0
	3	5.9	10.0	10.0	0.0	10.8	3.3
	2	5.9	6.7	6.7	3.3	2.7	0.0
	L 1	0.0	0.0	0.0	0.0	5.4	0.0

6 MV Missing Values

		CPS	CPSW	CRM	CORT	RUBINSTEIN	REID
PROCESS							
	MV			16.7			
4. The degree to which the course met the needs of the class.	H 7	2.9	0.0	0.0	3.3	2.7	6.7
	6	29.4	31.0	13.3	26.7	8.1	33.3
	5	32.4	37.9	43.3	40.0	18.9	30.0
	4	26.5	20.7	13.3	26.7	35.1	13.3
	3	8.8	10.3	10.0	3.3	13.5	6.7
	2	0.0	0.0	3.3	0.0	2.7	0.0
	L 1	0.0	0.0	0.0	0.0	5.4	0.0
	MV			16.7			
5. The process of openness, spontaneity, and humor, exhibited by the instructor.	H 7	21.5	30.0	13.3	36.7	10.8	43.3
	6	52.9	43.3	36.7	46.7	37.8	33.3
	5	8.8	20.0	16.7	16.7	18.9	6.7
	4	8.8	3.3	10.0	0.0	16.2	3.3
	3	2.9	0.0	3.3	0.0	2.7	3.3
	2	0.0	3.3	3.3	0.0	0.0	0.0
	L 1	0.0	0.0	0.0	0.0	0.0	0.0
	MV			16.7			
6. The degree to which the instructor encouraged group cohesiveness, trust and responsibilities.	H 7	23.5	13.3	6.7	20.0	2.7	30.0
	6	52.9	40.0	23.3	36.7	35.1	30.0
	5	17.6	26.7	26.7	33.3	32.4	20.0
	4	2.9	16.7	6.7	10.0	8.1	6.7
	3	0.0	3.3	10.0	0.0	5.4	3.3
	2	2.9	0.0	6.7	0.0	2.7	0.0
	L 1	0.0	0.0	3.3	0.0	0.0	0.0

		CPS	CPSW	CRM	CORT	RUBINSTEIN	REID
EXPERIENCE							
	MV			16.7			
7. The amount of learning I experienced.	H 7	2.9	3.3	6.7	3.3	2.7	13.3
	6	26.5	26.7	23.3	33.3	21.6	30.0

	5	38.2	40.0	26.7	33.3	24.3	26.7
	4	14.7	13.3	16.7	23.8	21.6	16.7
	3	11.8	10.0	10.0	6.7	8.1	3.3
	2	5.9	6.7	6.7	0.0	2.7	0.0
	L 1	0.0	0.0	3.3	0.0	5.4	0.0
	MV			16.7			
8. The extent of enjoyment I experienced in this course.	H 7	5.9	10.0	6.7	17.2	10.8	13.3
	6	35.3	30.0	26.7	34.5	16.2	26.7
	5	29.4	30.0	20.0	24.1	24.3	36.7
	4	20.6	10.0	13.3	24.1	13.5	10.0
	3	0.0	10.0	10.0	0.0	5.4	3.3
	2	5.9	6.7	3.3	0.0	10.8	0.0
	L 1	2.9	3.3	3.3	0.0	5.4	0.0
	MV			16.7			
9. The extent to which the course was relevant to my life.	H 7	2.9	10.0	0.0	6.7	5.4	3.3
	6	23.5	23.3	10.0	23.3	13.5	23.3
	5	29.4	16.7	26.7	20.0	27.0	36.7
	4	23.5	30.0	20.0	26.7	18.9	16.7
	3	8.8	16.7	23.3	13.3	2.7	10.0
	2	2.9	0.0	0.0	10.0	10.8	0.0
	L 1	8.8	3.3	3.3	0.0	8.1	0.0

TABLE No. 10-C
PROCESS AND EXPERIENTIAL VARIABLES FOR PROCESS ORIENTED PROGRAMS AND GENERAL FAMILIAR KNOWLEDGE

		Process-oriented			General Familiar Knowledge	Heuristics	
		CPS	CPSW	CRM	CORT	RUBINSTEIN	REID
CONTENT							
1. The extent to which I understood the information presented.	HIGH	79.4	76.7	43.3	73.3	51.3	76.7
	MEDIUM	17.6	16.7	30.0	23.3	18.9	10.0
	LOW	2.9	6.6	10.0	3.3	16.2	3.3
2. The extent to which I agreed with the information.	HIGH	47.3	76.7	50.0	89.7	45.9	70.0
	MEDIUM	11.8	10.0	30.0	10.0	27.0	16.7
	LOW	5.8	13.3	3.3	0.0	13.5	3.3
3. The extent to which I valued the information presented.	HIGH	73.5	56.6	49.9	66.7	43.2	56.6
	MEDIUM	14.7	16.7	16.7	30.0	24.3	30.0
	LOW	11.3	16.7	16.7	3.3	18.9	3.3
PROCESS							
4. The degree to which the course met the needs of the class.	HIGH	64.7	68.9	56.6	70.0	29.7	70.0
	MEDIUM	26.5	20.7	13.3	26.7	35.1	13.3
	LOW	8.8	10.3	13.3	3.3	21.6	6.7

		CPS	CPSW	CRM	CORT	RUBINSTEIN	REID
5. The process of openness, spontaneity, and humor,	HIGH	83.2	93.3	66.7	100.1	67.5	83.3
exhibited by the instructor.	MEDIUM	8.8	3.3	10.0	0.0	16.2	3.3
	LOW	2.9	3.3	6.6	0.0	2.7	3.3
6. The degree to which the instructor encouraged	HIGH	94.0	80.0	56.7	90.0	70.2	80.0
group cohesiveness, trust and responsibilities.	MEDIUM	2.9	16.7	6.7	10.0	8.1	6.7
	LOW	2.9	3.3	20.0	0.0	8.1	3.3
EXPERIENCE							
7. The amount of learning I experienced.	HIGH	67.6	70.0	56.7	69.9	48.6	70.0
	MEDIUM	14.7	13.3	16.7	23.8	21.6	16.7
	LOW	17.7	16.7	20.0	6.7	16.2	3.3
8. The extent of enjoyment I experienced in this	HIGH	70.6	70.0	53.4	75.8	51.3	76.7
course.	MEDIUM	20.6	10.0	13.3	24.1	13.5	10.0
	LOW	8.8	20.0	16.6	0.0	16.2	3.3
9. The extent to which the course was	HIGH	55.8	50.0	36.7	50.0	45.9	63.3
relevant to my life.	MEDIUM	23.5	30.0	20.0	26.7	18.9	16.7
	LOW	20.5	20.0	26.6	23.3	21.6	10.0

IMPACT ON ACADEMIC PERFORMANCE

To what extent do problem solving programs influence the academic performance of students? Do students enroll in different problem solving programs show a significant improvement in their overall average for the semester compared with their previous semester's record & with students in the control group? Would they show improvement in other courses of a problem solving nature such as math, physics, chemistry, computer science and economics? What difference does each program make?

Significant differences were noted in the following programs with regard to improvement in other courses of a problem solving nature. CPSW ranked first (Gamma .82), followed by the new proposed course, Section B (Gamma .68), CRM Multimedia (Gamma .67), Rubinstein's Pattern of Problem Solving (Gamma .60), CPS (Gamma .52), the new proposed course (Gamma .49), De Bono's CORT Thinking (Gamma .49) and finally Reid's Applied Problem Solving Through Creative Thinking (Gamma .34).

As for the impact on overall averages, we were not able to calculate the correlation due to the high number of missing values, varying between 80.0% for Section A, 74.1% for

Section B, and 77.2% for the total sample. However, considering other courses it is evident that they have impact. CPS and CPSW ranked first (Gamma .94 and .88) followed by Rubinstein's Pattern of Problem Solving (Gamma .72), De Bono's CORT Thinking (Gamma .58), CRM Multimedia (Gamma .37) and Reid's Applied Problem Solving Through Creative Thinking (Gamma .24). (See Table No. 10). These results support the conclusion reached in the 1986/87 and 87-88 studies (Assaad, 1987 and

1988). The impact on students' academic performance in CPS and CPSW can be explained by the fact that the teaching of learning skills is a part of P.S. requirements. Therefore it is highly recommended that this variable continue to be included in any new proposed course.

TABLE No. 11

Correlation of average in the current semester with previous semesters measured by Gamma for the different programs

ACADEMIC PERFORMANCE PROGRAMS	PROBLEM SOLVING NATURE COURSES	COLLEGE AVERAGE BY AVERAGE THIS SEMESTER
I Process-oriented		
1. CPS	.57	.94
2. CPSW	.82	.88
3. CRM	.67	.37
II General Familiar Knowledge		
4. CORT	.49	.58
III Heuristics in a well-structured Domain		
5. Rubinstein	.60	.72
IV Combination		
6. Reid	.34	.24
7. CPS A	.36	
8. CPS B	.68	
9. Total Sample	.49	
V Control 1	.12	-
Control 2	.15	-

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