Teaching Problem Solving and Creative Thinking
1986-1987

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RESUMÉ

Cette étude a permis d'évaluer trois stratégies pédagogiques utilisées dans un programme expérimental conçu pour faciliter le processus de résolution des problèmes pour les étudiants du réseau collégial. Son objectif principal était de comparer l'effet des approches intellectuelles, affectives et une combinaison cognitive/affectives sur la connaissance, les stratégies, les compétences, les attitudes, les aptitudes et la créativité des étudiants dans la résolution des problèmes. Le groupe expérimental comprenait 105 étudiants du Collège Champlain, Campus St-Lambert qui étaient inscrits dans un des trois différents cours de résolution de problème: le cours "Creative Problem Solving" (CPS) qui applique l'approche intellectuelle (n=37); le cours "Cort Thinking" un cours de Humanities qui applique l'approche affective (n=34); et un cours conçu sur les ateliers "Creative Problem Solving" qui applique un combinaison des approches intellectuelles et affectives (n=34). Le groupe de contrôle se composait de 68 étudiants inscrits à des cours analogues. Il était prévu que les étudiants dans le groupe expérimental démontreraient une meilleure connaissance, stratégie, compétence, attitude, aptitude et créativité dans la résolution des problèmes. Cette hypothèse a été évaluée par des examens antérieurs et postérieurs. Les résultats ont indiqué que pour toutes les variables, à l'exception de l'aptitude, les étudiants, qui ont suivi un cours qui traite de la résolution des problèmes, ont mieux réussi que les étudiants qui ne l'ont pas suivi.

Les résultats ont appuyé une recherche précédente en indiquant que ces stratégies d'enseignement sont mieux utilisées pour des objectifs pédagogiques spécifiques. L'approche intellectuelle était la plus effective dans l'enseignement de la connaissance de la résolution des problèmes (Gamma .79) et les stratégies (Gamma .36). L'approche affective a eu le plus d'impact sur l'attitude (Gamma .68) et sur les points en créativité (Gamma .45 à .52). Une amélioration moyenne pour toutes les variables a été obtenue avec l'approche combinée cognitive/affective. Les étudiants inscrits dans les cours de résolution de problème ont montré une amélioration significative dans leur moyenne générale lorsque comparée à la moyenne des semestres précédents (Gamma .79). Ces étudiants one également démontré une amélioration significative dans d'autres cours de même nature que la résolution de problème, tels que mathématiques, physique, chimie, informatique et économique (Gamma .59).

TABLE OF CONTENTS

INTRODUCTION

Colleges of general and vocational education (CEGEPS) have been in existence in the province of Quebec since September, 1967. The idea for this system was conceived by members of the Royal Commission of Inquiry on Education in Quebec.[1] This unique development in educational policy may be considered the hub of the reform of the school system in Quebec.

The twenty years of CEGEP existence can be devised into two periods: A rapid growth period during the first ten years and a period of stability during the last ten years. During the first period studies concentrated on thinking of new orientations which would allow the colleges to better satisfy the needs of the students (Conseil Superieur De L' Education, 1975).

Examinations on the functioning of these institutions have been conducted during the past ten years - the stable period - in order to identify weaknesses in the system, and thereby modify the system.

After twenty years of operation, the initial objective of the CEGEP system and the social changes should be examined. The role of CEGEPS in

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[1] Rapport de la Commission royal d'enquete sur l'enseignement dans la province de Québec, Quebec, Editeur officiel, 1963-1966, 5 volumes. See especially Tome II, Chapter VI: "L'enseignement pré-universitaire et professionnel."

developing the students' intellectual and critical thinking should be given special emphasis.[2]

The study of the effect of teaching problem-solving and creativity courses to CEGEP students falls within this perspective. It is an evaluation of the acquisition of the students problem-solving knowledge, procedures, skills, attitudes and aptitudes. It is testing the assumption that students come to college with a minimal acquisition of problem-solving skills. Finally, it is an evaluation of the impact of teaching problem-solving and creativity courses upon students intellectual abilities as well as determining the best teaching approach and the best setting for teaching such courses.

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[2] It should be noted here that two important research projects are in progress. The first is a study of the cognitive and affective growth of CEGEP students (Bateman 1986). The second is on "Programme de Developpement de la Pensée Formelle: Tome I Fondement Theorique" College de Linoilou 1986.

Theoretical Framework

Review of Literature

Research in the area of creative problem solving appears to support one major conclusion: problem solving strategies should be taught. (Suydam 1982). Indeed it is clear that the acquisition of creative problem-solving skills by students has been minimal at best. And this is true not only in Quebec and Canada but also in the United States and the Soviet block.[3] Moveover, the problem extends from the academic to the business environment, and from Science to Social Science programs.

Teaching problem solving and creativity as a separate subject is growing in North America. The skills taught in these courses have their intellectual foundation in the history of North American colleges and universities. (Whitman 1983).

In the United States, for example, university level programs have been created such as the University of Iowa's program to develop problem solving, ("see Bennett 1984") and the University of California, Los' Angeles (UCLA) campus wide course, "Patterns of problem solving". The

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[3] According to V.K. Zaretskii, I.N. Semenov and S.Y. Stepanov (1980), the Soviet Union is concerned with solving problems that require creativity as a function of different mental sets toward the problem. Several techniques were used to establish a productive rather than a reproductive set in participants. As a result, the former led to a higher success in problem solving. Their concern also extended to the importance of the relationship between both intellectual and personality aspects of problem solving strategies (Stepanov & Semenov 1982). The psychology of creative thinking and considering strategies for the problem solver to break away from experience bound patterns of thinking is one of their main concerns in the 1980's (Galperin 1982).

Future Problem Solving Program designed by E.Paul and P.Torrance, is now developing problem solving skills of 100,000 gifted children in grades four to twelve throughout the United States. (Hoomes 1984).

The Canadian need for developing problem solving skills was demonstrated by the University of Waterloo study (Woods, Crowe, Hoffman and Wright 1977). In Quebec the concern was mainly related to developing critical thinking. (Programme de Développement de la pensée formelle développé par le groupe 'Démarches' - Collège de Limoilou 1986). Their study regarding this process emphasizes the need for evaluation of the thinking skills involved in the problem solving process.

The need for teaching creative problem solving skills has extended from the science programs to the social science programs. (Horning and Stevens 1982; Polsinelli 1983). In addition, as a business trainee stated, the dissatisfaction goes beyond the educational sector to the business sector. Creative training and development of creative problem solving skills for employees is vital if a business is to grow and flourish in the 80's (Grossman 1982).

A survey of how various individual and institutions are teaching problem solving skills has been completed (Woods 1977). This survey reveals the difficulties faced by those teaching and attempting to improve problem solving skills. Some of these difficulties related to problems in the student`s background, problem solving strategies and

teaching methods and approaches. Examples of difficulties in students' background are:

- weakness in basic knowledge
- a lack of elementary skills of logic
- weak communication skills
- the acquisition of bad habits for problem solving
- a lack of motivation
- failure to recognize that problem solving is in itself a legitimate educational goal (Woods 1977).

The problem solving strategies that gave the most difficulty in teaching creative problem solving courses are:

- Subsystem identification and the relationships among the subsystems
- Relating subsystems to the theory and questions asked
- Simplifying the complex problems and making good assumptions
- Being creative
- Creating a hypothesis
- Anything regarding analysis (Ibid.)

The final set of difficulties is related to the approaches and methods of teaching the creative problem solving courses which involve questions such as:

- Which is the best approach: cognitive, affective (Shure & Spivak 1981) or a combination of both? (Gagné 1980)

- How to make and keep the course interesting especially after students realize that they are not going to get answers to all of their real life problems (Ross & Maynes 1983).

- How can the mental blocks to creative thinking be overcome? (Bradley & Friedenberg 1984; Ellen 1982; Glover 1981)

- What is the value of small round table or tutorial via regular classroom lecturing (Tindall 1982).

Students entering CEGEPs in Quebec have a minimal acquisition of problem solving skills. This is due to many factors, among them: rote learning, memorization and the elimination of some subjects such as geometry and the administration of mainly multiple choice type exams.

Since 1980 Champlain Regional College has been especially interested in developing research and development towards overcoming the problems of students' background. Studies have covered the effect of the Psychology of Learning courses (350-360) on students' pre-vs.post-test scores on study habits, study attitudes, focus of control, and self-concept, and on their study time and overall average. (Parpa Grant 1984-1985, Susan Kerwin-Boudreau). Results generally support the conclusion that study habits, attitudes and focus control were improved as a consequence of teaching learning skills (Boudreau, 1985).

At Champlain College research has also covered the cognitive and affective growth of CEGEP students (Parpa Grant 1985/86 and 1986/87 - Diane Bateman). Preliminary findings suggest that student increase their vocabulary and thinking skills, particularly their ability to infer, deduce, and interpret information. There is also evidence of an

increase in moral development and the development of a more sophisticated attitude toward knowledge and learning (Bateman 1985-1986).

In the area of problem solving and creativity the author's study is evaluating the effect of teaching problem solving and creativity courses on students' problem solving knowledge, skills, attitudes and aptitudes.

Since 1981, the author has been offering three problem solving courses; creative problem solving (C.P.S.), creative problem solving workshop (CPSW) and Games and Decisions which teaches De Bono's CORT thinking course (CORT). Since that time he has been involved in the development of this area and has produced a manual entitled Creative Problem Solving (1981) designed to develop the above mentioned knowledge and skills. He has also developed and adapted different tests to measure the progress of his students. The development of the creative problem solving courses at Champlain College was accompanied by the application of three different approaches: the cognitive approach for the CPS course, the affective approach for the Games and Decisions Course, and a combination of the cognitive and affective approach for the CPSW course. The cognitive approach used in teaching the CPS course is mostly discipline, while a combination of discipline and problem solving cases is used to teach the CPSW course. However, solving problem cases is the sole emphasis in the Games & Decisions course. All of the above reflects the emphasis of each course. In the CPS course the emphasis is on strategy and the steps in solving problems, while in the Games & Decisions course

the emphasis is on elements such as creativity. In CPSW courses both strategy and elements are emphasized.

The types of problems utilized in the CPS course are mainly analytical, requiring logical reasoning. These analytical problems can be classified into ordinary homework or open-ended (divergent) types which require the problem solver to generate many alternative solutions and select the suitable one. In the Games & Decisions course, the problems are mainly judgmental and creative, requiring the exercise of judgment and creative thinking. Once again, the CPSW is a combination of the types of problems used in the other two courses.

It is proven in the literature related to problem solving that students participating in a problem solving skill training program demonstrate better problem solving skills and higher levels of self-esteem than the students in the control group. This research was done on American junior high school students, which included grades seven to nine. (Tellado, G. 1984). To the best of my knowledge nothing has been done to evaluate the problem solving skills of college students in Quebec.

The general objective of this study is to measure in a more systematic way the effect these courses have on the students' knowledge, skills, attitudes, and aptitudes. This will be done by comparing the results of the students registered in these courses with those of a control population of students in the college. By comparing these courses we will identify the most efficient approaches and methods for teaching

this subject. Finally, the results of this research will fulfill the need in the academic community to overcome some of the problems mentioned earlier in this section.

The specific objectives of this research are as follows:

1. To determine the effect of teaching problem solving and creativity as separate courses (CPS, Games & Decisions, CPSW) on the students' knowledge of problem solving strategy (procedures), problem solving skills, attitudes, as well as aptitudes towards problem solving and creativity. This will be done by comparing pre-test scores of students enrolled in these courses with the results obtained from the control objects enrolled in the college who did not take these courses.

2. To test the effectiveness of the system developed at Champlain Regional College in improving the above knowledge, skills and attitudes.

3. To compare the impact of these three different approaches and methods: cognitive, affective or a combination of both in developing the skills involved. This comparison will lead to the selection of the most suitable approach. This will be done by comparing the students' performance in the three courses under study and finding out which approach reveals the best results in the post-tests.

4. To measure the effect of studying problem solving as a separate course on the students' performance in other courses which involve problem solving nature. This will determine to what extent problem solving courses help the students to overcome the difficulty of transferring what they have learned to other courses and situations of a problem solving nature.

5. To measure the relationship between the dependent variables in terms of the impact of change of one variable on the others. An example would be the impact of changing attitudes towards P.S. on other variables such as P.S. knowledge or skills. The same would apply to the change in aptitudes on other variables such as P.S. knowledge or skills. The knowledge of the procedures and their impact on P.S. knowledge, attitudes, skills and aptitudes will be examined.

6. To determine the impact of the students' social background on their problem solving knowledge, skills, attitudes and aptitudes by focusing on sex, age, social class, income, previous schooling, program, high school average, number of years in college, number of credits accumulated, experience, family environment.

Methodology

The Research Design

This research project will study the relationship between the independent variables (studying problem solving courses by applying different approaches) and the dependent variables (problem solving knowledge, procedures, skills, attitudes and aptitudes).

Design of Proof

The basic research design studies the effect of treatment using three different courses: Creative problem solving (CPS), Problem Solving Workshops (CPSW) and Games & Decisions which teaches CORT thinking. A comparison of the measures of knowledge, procedures, skills, attitudes and aptitudes taken before the treatment and after the treatment will be made.

The basic design can be illustrated as follows:

	Independent Variables	Dependent Variables
	CPS Course 37	Content variables - P.S. Knowledge - Knowledge of
Social background variables	CPSW Course 34	- P.S. Stages - P.S. Skills - P.S. Attitudes - P.S. Aptitude
	CORT Thinking Course 34 (Games & Decisions)	- CREATIVITY Process variables
	Control Group 1	
	Control Group 2	Experiential Variables

Validity

The only threats to internal validity in this study are testing and instrumentation on one hand and coding reliability for open ended questions on the other. Testing is a threat when a subject is exposed to a test more than once. Performance may be altered due to the previous testing because the person may recall questions from the previous test. The mood may also play a part if he or she becomes bored and careless. Changing the testing instrument may actually create the

instrumentation problem because individual changes may be due to the change in the testing instrument(s).

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

The second threat is related to coding[4] reliability for open ended questions. This problem occurs when the coder has to categorize the respondents' answer 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 make a global judgement 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 were given to the coders. Finally, every set of pre- and post-tests was coded separately by two coders. Their independent judgments were then examined, and they discussed any difference in order to agree on a final judgment. The advantages of the double coding is to

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[4] In the present context, coding is simply a technique for placing all participants in the experiment along a given dimension or within classification scheme on the basis of their responses.

provide statistical evidence on the reliability of the judgement being made.[5]

As regards "closed" questions with specific answers, apart from clerical errors, the coding reliability of this procedure is perfect.

Hypotheses

1. It is an hypothesis that students enrolled in creative problem solving courses will show greater improvement on the pre vs. post-test measures of content variables of problem solving knowledge, procedures or stages, skills, attitudes and aptitudes.

2. It is also an hypothesis that students enrolled in creative problem solving courses will show greater improvement on their pre or post-test on the Creativity and Innovations index tests.

3. It is more likely that students taking these courses will score higher on the process and experiential variables.

4. It is more likely that at the college level, a cognitive/affective approach will produce more improvement in problem solving knowledge, procedures, skills, attitudes and aptitudes as compared with only cognitive or affective approaches.

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

5. It is also an hypothesis that students in the creative solving courses will show a significant improvement in other courses of a problem solving nature.

6. It is more likely that the students enrolled in CPS courses will have an improved overall average for the semester in which they are enrolled as opposed to their previous semester's record (as compared with the average of the control sample).

7. The change in attitudes has an important impact in developing problem solving knowledge, skills and aptitudes.

Instruments and Measures

The measuring instruments for this research were selected or 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 the courses was measures in two ways. First, by the mid-term and final exam

marks. Second, by a modified checklist developed by Kenneth M. Cinnamon and Norman J. Matulef (1979). For this measure, students were asked to define terms and give concrete examples taken from their own experience. They were also asked to rate the importance of each item as 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 process or procedures.

The checklist also measures the student's knowledge of the problem solving processes or procedures by testing them on terms such as 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 problems, define and classify problems, determine goals and objectives and strategies, manage time, ability to memorize information, to think in an abstract way, 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). (For details consult the pre-test document.)

Creativity

The instrument 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 the previous tests has proven to be helpful in identifying creativity. The first test "word hints to creativity" is based

upon the Remote Associates Test developed by Dr. Sarnoff A. Mednick of the University of Michigan and Dr. Sharon Halpern of the University of California at Berkeley. Extensive experimentation with this test has been and is being carried on. The sample drawings for "Picture Test Creativity" are from the Barron-Welsh Art Scale. Several studies with this test have shown that creative individuals show a marked preference for the complex and 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 or not 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." He says that it is not physical courage, though a highly creative person may have courage of this kind too. It is rather 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 the fourth test (personality checklist) are based on several questionnaires used in creativity studies, including the Myers-Briggs Type Indicator, the Cree Questionnaire, California Psychological Inventory, and many others.

The test has proved 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.[6]

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

Aptitude Variables

Aptitude variables in this study are: reasoning, operational analysis, classification (figure classification), analogies and comprehension).

These aptitudes were measured by tests developed by the author, having been adapted from the IBM, Univac, Honeywell and NCR aptitude tests.

II Process Variables

The measurement of the effectiveness of the evaluation of the structuring format for the three courses under study was accomplished through two feedback questionnaires. The first was completed in the mid-term period and the second at the end of the course.

Participant observation consisted of monitoring and recording body language, vocal patterns and seating arrangements. The following process variables were accounted for:

1. Degree to which the course format and content meet the needs of the class.
2. Extent to which the tone and pace of the training were comfortable for the group.
3. Degree to which expectations of the amount of skill development were met in the class.

4. Ability of the instructor to track and describe accurately methods and styles of problem solving.

5. Extent to which the instructor helped to generalize course principles to the actual work setting.

6. Degree of openness, spontaneity, humor and energy exhibited by the instructor.

7. Degree of consistency between the instructor's style and the materials and exercises he/she presented.

8. Ability of the instructor to assist individuals in formulating their own solutions.

9. Extent to which the instructor fielded responses and questions of class members with sensitivity and respect.

10. Degree to which the instructor encouraged group cohesiveness, trust and responsiveness.

Evaluation instrument No. 6 in the pre- and post-tests asks the students to rate each of these ten variables on a ten-point scale.

III Experiential Variables

Experiences during the course were evaluated according to five variables:

1. The degree of clarity and organization

2. The amount of learning

3. The extent of enjoyment

4. The degree of value and relevance to the actual or future work setting.

5. The ability of the instructor to direct and process the activity.

Evaluation instruments No. 6 in the pre- and post-test measures the previous experience variables. Finally, evaluation instrument No. 6.3 covers all three: content, process and experience variables in a general form.

All the previous instruments were compiled into two documents called the Pre-test and Post-test (see Appendix I).

Subjects

The experimental group was composed of 105 students enrolled during the 1986-87 academic year in the following three courses: Creative Problem Solving (905-102-81-A) (N 37), Creative Problem Solving Workshop (905-102-81-B) (N 34), Games and Decisions (345-301-A) (N 34). The control group consisted of 68 students registered in comparable courses: International Politics (N 35), Humanities (N 33). This control group is divided into Control Group 1 (International Politics) and Control Group 2 (Humanities).

Procedure

The pre-tests including the aforementioned batteries were administered to the five classes (experimental and control groups) on the first day of class of the Fall 1986 session.

Students enrolled in the experimental group courses were introduced to the theory and practice of problem solving and creativity. The text book for CPS and CPSW courses was a manual developed by the author entitled Creative Problem Solving, Champlain Regional College, 1981. The reading materials for the Humanities course CORT Thinking were developed by De Bono in his system.

The approach used to teach CPS was primarily discipline, while a combination of discipline and problem solving was used in teaching the CPSW (cf. Shure and Spivak 1981; Gagné 1980). The Humanities course, however, was taught using exclusively problem solving cases. 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 problems, judgmental and analytical, which are classified under logical or textbook type of questions. Problem solving knowledge also includes awareness of problem solving requirements: learning (planning, making connections and study skills), analysis (classification, structural and operational) and creativity. Twelve items of problem-solving knowledge are listed in the pre- and post-tests. Participants were asked to define each item and to describe all

corresponding examples. The data indicated a significant difference between the experimental group and the control group.

Problem Solving Knowledge

Measured by P.S. Checklist

Results by course	CPS		CPSW		CORT		Control Group 1		Control Group 2	
P.S. Knowledge score	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %
91-100	0	2.7	0	8.8	0	8.8	0	0	0	0
81-90	0	13.5	0	23.5	0	11.8	0	0	0	3
71-80	2.7	27.0	0	8.8	2.9	14.7	5.9	5.9	6.1	6.1
61-70	10.8%	35.1	2.9	14.7	8.8	29.4	0	11.8	18.2	21.2
0-59	86%	21.6	97.1	44.1	88.2	35.3	91.1	82.4	75.8	69.7
	(N. 37)		(N. 34		(N. 34)		(N. 34)		(N. 33)	
Gamma	0.79		1.00		.31		.58		1.0	
Pearson's R	0.39		0.31		.08		.12		.91	
Signif-icance	.009		.05		.32		.24		00	

Course comparisons of pre-scores on problem solving knowledge vs post-score yielded higher results for the three experimental groups than for the control group. As a consequence of taking problem solving courses,

(Gamma. 38). CPSW contributed to developing alternatives (Gamma .23) as well as evaluation (.19) and selection of alternatives (.28). CORT Thinking contributed mainly to developing alternative (.30), selection of alternatives (.62) and rationalization and implementation (.28).

Problem Solving Procedures (Stages)

for Experimental and Control Groups

		Experimental Group		Control Group	
Problem Identification	Gamma	.06		-.04	
		Pre	Post	Pre	Post
	H	1.0	23.8	1.5	1.5
	M	27.6	48.6	17.9	34.3
	L	71.4	27.6	80.6	64.2
Developing Alternatives	Gamma	0.17		.20	
	H	5.7	32.4	6.0	7.5
	M	42.9	48.6	20.9	23.9
	L	51.4	19.0	73.1	68.6
Evaluation	Gamma	-0.003		.02	
	H	0	25.7	0	1.5
	M	29.5	44.8	13.2	22.1
	L	70.5	29.6	86.8	76.5
Selection	Gamma	.35		.17	
	H	2.9	21.9	6.0	10.4
	M	29.5	48.6	23.9	28.4
	L	67.6	29.6	70.1	61.2
Rationalization & Implementation	Gamma	.20		-.78	
	H	0	15.2	0	0
	M	19.0	46.7	13.6	21.2
	L	81.0	38.1	86.4	78.8

53-65% were able to score above the passing mark of 59% as compared to only 5-9% for the control groups.

A comparison of the three courses indicates that CPS course students achieved the highest overall results. Out of 64.3% who were below the passing mark in the pre-test and were able to pass in the post-test: 24.3% obtained between 61-70%, 24.3% between 71-80%, 13.5% between 81-90% and 2.7% over 91%.

As for the CPSW the percentage of those who were able to pass is lower at 52.9%, although the percentage of those who obtained sufficient knowledge is higher. For example, more students received a mark between 81-90% in the CPSW course (23.5%) as compared with the CPS course (13.5%).

For the Humanities Games and Decisions course, the percentage of those who passed is the same as CPSW at 52.9%, while the level of improvement is lower than both CPSW and CPS.

Problem Solving (Strategies)

Problem solving procedures or strategies deals with the various stages of problem solving. The question here is to what extent the subjects can understand and differentiate the various stages of problem solving (i.e., problem identification, basic problem identification, developing alternatives, evaluation, solution selection, rationalization and

implementation). Included within these stages are sub-variables stages such as: subsystem identification and the relationship among the subsystems, relating subsystems to the theory and questions asked, simplifying the complex problems and making assumptions, creating hypotheses, and creativity.

The instrument for evaluating knowledge of problem solving procedures contains eight questions. The participants were asked to define each term and to describe a corresponding on-the-job example. Results of the data reveal that 46.7% of subjects in the experimental group improved in their pre-post-test scores on problem solving (Gamma .38) compared with 10.4% for the control group (Gamma .09). Out of the 46.7%, 18.1% rated average and 21% rated high. All the 10.4 (control group) improvement remained in the average category. Comparing the scores on problem solving procedures for the three courses under study in their impact on the problem solving procedures revealed that: CPS ranked first (Gamma .36) followed by Humanities/CORT Thinking (Gamma .30) and finally CPSW (Gamma .27).

Problem Solving Procedure

Pre- vs Post-test by Experimental Group and Control Group

Results	Experimental Group		Control Group	
	Pre	Post	Pre	Post
High	1.9	22.9	0	0
Average	34.3	52.4	20.9	31.3
Low	63.8	17.1	79.1	31.3
Missing Values	0	7.6		37.3
Gamma		.38		-.09
Persons's R		.19		-.12
Significance		0.02		.17

Problem Solving Procedures

Pre- vs Post-test by Course

Course	CPS		CPSW		CORT		Control 1		Control 2	
Results	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	5.4	27.0	0	29.4	0	11.0	0	0	0	0
Average	43.2	56.8	35.3	44.1	23.5	55.9	8.6	20.6	34.4	43.8
Low	51.4	16.2	64.7	16.4	76.6	32.4	91.4	79.5	65.6	56.3
Gamma	.36		.24		.30		0.08		-.03	
Pearson's R	.18		.11		.20		.01		-.12	
Significance	.14		.27		.13		.47		.25	

Comparing the pre- and post-test scores for each stage of problem solving procedures suggests that problem solving courses have a significant impact on problem identification (Gamma for experimental group is .06 compared with .04 for Control group) and on selection of alternatives (Gamma is .35 for experimental compared with .17 for control).

Each course contributed differently to the development of each stage. CPS contributed more to the evaluation (Gamma .23) selection of alternatives (Gamma .27) and rationalization and implementation

Problem Solving Procedures
Pre- vs Post-test by Course

(Gamma is used for correlation)

Course P.S.Procedures Pre-vs Post by course		CPS		CPSW		CORT		Control 1		Control 2	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Problem Identification	Gamma	-.06		.02		.16		-.26		.18	
	H	.0	24.3	2.9	29.4	0	17.6	0	0	3.1	3.1
	M	37.8	48.6	20.6	44.1	23.5	52.9	5.7	22.9	31.3	46.9
	L	62.2	18.9	76.5	17.6	76.5	23.5	94.3	77.2	63.6	50.0
Developing Alternatives	Gamma	.04		.23		.30		.16		.40	
	H	10.8	29.7	5.9	44.1	0	23.5	0	29	12.5	12.5
	M	45.9	54.1	41.2	35.3	41.2	55.9	8.6	14.3	34.4	34.4
	L	43.2	16.2	52.9	19.6	58.8	20.6	91.4	82.9	53.1	43.1
Evaluation	Gamma	-.23		.19		-.11		.27		.08	
	H	.0	18.9	0	35.3	0	23.5	0	2.9		
	M	45.9	59.9	23.5	35.3	17.6	38.2	5.7	11.4	21.2	33.3
	L	54.1	21.6	76.5	29.4	82.4	38.3	94.3	85.7	78.8	66.6
Selection of best solution	Gamma	.27		.28		.62		.11		.41	
	H	2.7	16.2	5.9	32.4	0	17.6	0	2.9	12.5	18.8
	M	32.4	48.6	20.6	35.3	35.3	61.8	8.6	25.7	40.6	31.3
	L	64.9	35.1	73.5	32.3	64.7	20.6	91.4	71.5	46.9	50.0
Rationalization & Implementation	Gamma	.38		-.11		.28		.82		.57	
	H	.0	10.8	0	23.5	0	11.8	0	0	0	0
	M	27.0	56.8	8.8	41.2	20.6	41.2	6.1	9.1	21.2	33.3
	L	73.0	32.4	91.2	35.3	79.4	47.1	93.9	90.9	78.8	66.6

Attitudes

The purpose of this section is to determine whether courses in creative problem solving affect attitudes towards creative problem solving.

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

Our objective in this section is to determine whether the same positive attitudes towards problem solving and creativity would occur in CPS and creative thinking courses taught at the CEGEP level.

Results of the data revealed that for the attitude instrument the experimental subjects improved in their pre- post-test scores while control subjects did not. Data for the experimental group showed that 100% of those who were very negative in their attitudes became extremely positive; 33% of the neutral became extremely positive; of those who were neutral (N .36) 58.3% moved to the positive categories: 25% positive, 16.7% very positive and 16.7 extremely positive. Of those who were positive (N .26) 42.3 moved to higher categories; 30.8 became very positive, 11.5 became extremely positive. Only 11.5 moved from positive

to neutral. For the very positive category (N .13) 38% became extremely positive, the rest either remained the same and a very small percentage 7.7 became positive. Out of those who were extremely positive (N .16) 56.3 remained the same, 25% became very positive, 6.3% became positive and 12.5% became neutral. The general observation is that CPS courses develop more positive attitudes towards problem solving and creativity.

Pre- vs Post-tests
Experimental Group

COUNT / ROW PCT / COL PCT / TOT PCT		POST-TEST Extremely Positive	Very Positive	Positive	Neutral	Row Total
PRE-TEST						
Extremely Positive	1	9.0 56.3 36.0 9.5	4.0 25.0 16.0 4.2	1.0 6.3 4.3 1.1	2.0 12.5 9.1 2.1	16 16.8
Very Positive	2	5.0 38.5 20.0 5.3	7.0 53.8 28.0 7.4	1.0 7.7 4.3 1.1	0 0.0 0.0 0.0	13 13.7
Positive	3	3.0 11.5 12.0 3.2	8.0 30.8 32.0 8.4	12.0 46.2 52.2 12.6	3.0 11.5 13.6 3.2	26 27.4
Neutral	4	6.0 16.7 24.0 6.3	6.0 16.7 24.0 6.3	9.0 25.0 39.1 9.5	15.0 41.7 68.2 15.8	36 37.9
Negative	5	1.0 33.3 4.0 1.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2.0 66.7 9.1 2.1	3 3.2
Very Negative	7	1.0 100.0 4.0 1.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.1
	Column Total	25 26.3	25 26.3	23 24.2	22 23.2	95 100.0

Gamma = 0.46791

The same pattern emerges when comparing the pre-test attitude towards CPS courses with the post-test results

COUNT / ROW PCT / COL PCT / TOT PCT	POST-TEST Very Positive	Positive	Neutral	Very Negative	Row Total
PRE-TEST					
Very Positive 1	14.0	8.0	1.0	1.0	24.0
	58.3	33.3	4.2	4.2	25.3
	40.0	20.0	5.3	100.0	
	14.7	8.4	1.1	1.1	
Positive 2	16.0	25.0	10.0	0.0	51.0
	31.4	49.0	19.6	0.0	53.7
	45.7	62.5	52.6	0.0	
	16.8	26.3	10.5	0.0	
Neutral 3	5.0	6.0	8.0	0.0	19.0
	26.3	31.6	42.1	0.0	20.0
	14.3	15.0	42.1	0.0	
	5.3	6.3	8.4	0.0	
Very Negative 5	0.0	1.0	0.0	0.0	1.0
	0.0	100.0	0.0	0.0	1.1
	0.0	2.5	0.0	0.0	
	0.0	1.1	0.0	0.0	
Column Total	35	40	19	1	95
	38.8	42.1	20.0	1.1	100.0

Gamma = 0.40567

In the control group, results show either little or no change in attitudes. Those who reported negatively on the pre-test (N .1) moved to neutral on the post, while of those who were neutral 62.5% remained neutral, 12.5% moved to the negative end of the scale and another 12.5% moved to positive.

Among those who were very positive on the attitude scale, 57.1% remained the same; 14.1% moved to a lower attitude category and 26.6% moved to a higher category. Finally, for those who were extremely positive, 50% remain the same and 50% moved towards lower categories. The same pattern was revealed for the attitudes towards CPS and Creativity courses.

Attitudes Towards Problem Solving and Creativity Courses
Pre- vs Post for Control Group

COUNT / ROW PCT / COL PCT / TOT PCT		POST-TEST Very Positive	Positive	Neutral	Negative	Row Total
PRE-TEST						
Very Positive	1	5.0	5.0	3.0	0	13.0
		38.5	38.5	23.1	0.0	29.5
		62.5	23.8	21.4	0.0	
		11.4	11.4	6.8	0.0	
Positive	2	2.0	11.0	3.0	0.0	16.0
		12.5	68.8	18.8	0.0	36.4
		25.0	52.4	21.4	0.0	
		4.5	25.0	6.8	0.0	
Neutral	3	1.0	5.0	8.0	1.0	15.0
		6.7	33.3	53.3	6.7	34.1
		12.5	23.8	57.1	100.0	
		2.3	11.4	18.2	2.3	
Column Total		8.0	21.0	14.0	1.0	44.0
		18.2	47.7	31.8	2.3	100.0

Conditional Gamma = 0.53456

Pre- vs Post Control Group

COUNT / ROW PCT / COL PCT / TOT PCT		POST-TEST: Extremely Positive	Very Positive	Positive	Neutral	Negative	Row Total
PRE-TEST: Extremely Positive	1	7.0	6.0	1.0	0.0	0.0	14.0
		50.0	42.9	7.1	0.0	0.0	31.1
		58.3	37.5	12.5	0.0	0.0	
		15.6	13.3	2.2	0;0	0.0	
Very Positive	2	4.0	8.0	1.0	1.0	0.0	14.0
		28.6	57.1	7.1	7.1	0.0	31.1
		33.3	50.0	12.5	12.5	0.0	
		8.9	17.8	2.2	2.2	0.0	
Positive	3	0.0	2.0	5.0	1.0	0.0	8.0
		0.0	25.0	62.5	12.5	0.0	17.8
		0.0	12.5	62.5	12.5	0.0	
		0.0	4.4	11.1	2.2	0.0	
Neutral	4	1.0	0.0	1.0	5.0	1.0	8.0
		12.5	0.0	12.5	62.5	12.5	12.5
		8.3	0.0	12.5	62.5	100.0	
		2.2	0.0	2.2	11.1	2.2	
Negative	5	0.0	0.0	0.0	1.0	0.0	1.0
		0.0	0.0	0.0	100.0	0.0	2.2
		0.0	0.0	0.0	12.5	0.0	
		0.0	0.0	0.0	2.2	0.0	
Column Total		12.0	16.0	8.0	8.0	1.0	45.0
		26.7	35.6	17.8	17.8	2.2	100.0

Gamma = 0.75

Attitudes towards Problem Solving and Creativity
Pre- vs Post-test by Experimental and Control Groups

Groups	Experimental		Control	
Attitudes	Pre	Post	Pre	Post
1. Extremely Positive	16.8	26.3	31.1	26.7
2. Very Positive	13.7	26.3	31.1	35.6
3. Positive	27.4	24.2	17.8	17.8
4. Neutral	37.9	23.2	17.8	17.8
5. Negative	3.2	0.0	2.2	2.2
6. Very Negative	0.0	0.0	0.0	0.0
7. Extremely Negative	1.1	0.0	0.0	0.0
Gamma	0.47		0.75	
Pearson's R	0.36		71.0	
Significance	.0002		0.0	

Attitudes Towards CPS and Creativity Courses
Pre- vs Post-test by Experimental and Control Groups

Groups	Experimental		Control		Correlation for for each category measured by Gamma	
Attitudes	Pre	Post	Pre	Post	Exp.	Cont.
1. Very Positive	25.3	36.8	29.5	18.2	0.82	1.00
2. Positive	53.7	42.1	36.4	47.7	0.65	0.92
3. Neutral	20.0	20.0	34.1	31.8	-0.37	0.82
4. Negative	0.0	0.0	0.0	2.3	0.79	1.00
5. Very Negative	1.1	1.1	0.0	0.0	-	-
Gamma		0.41			0.53	
Pearson's R		0.36			0.40	
Significance		0.01			0.0003	

A comparison of the three courses shows that the Humanities course - CORT Thinking - has the highest impact on attitude change towards problem solving and creativity (Gamma .68) followed by CPS (Gamma .33) and finally CPSW (Gamma is only .12). With regard to attitudes towards problem solving courses the Humanities course once again has the highest impact on attitude change (Gamma .41) followed by CPSW (Gamma .30) while CPS did not produce change in attitudes towards CPS courses (Gamma .003).

Attitude Towards Creativity and Problem Solving
Pre- vs Post-test Results by Course

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Attitude	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Extremely Positive	18.9	21.6	17.6	35.3	11.8	14.7	8.8	17.6	39.4	24.3
Very Positive	13.5	27.0	8.8	14.7	20.6	29.4	29.4	38.2	18.2	24.2
Positive	32.4	21.6	23.5	26.5	26.5	23.5	20.6	26.5	9.1	9.1
Neutral	27.0	21.6	41.2	14.7	38.2	26.5	2.9	11.8	30.3	15.2
Negative	5.4	0.0	2.9	0.0	2.9	0.0	2.9	0.0	0.0	3.0
Extremely Negative	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Missing Values	2.7	8.1	2.9	8.8	0.0	5.9	35.3	5.9	3.0	24.2

Gamma	33.0	0.12	0.68	0.46	0.08
Pearson's R	28.0	0.06	0.57	0.45	0.18
Significance	0.05	0.36	0.0002	0.004	0.15

Attitude towards P.S. Courses
Pre- vs Post-test Results by Course

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
	%		%		%		%		%	
Attitude	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Extremely Positive	0.0	8.3	0.0	8.8	0.0	5.9	0.0	0.0	0.0	0.0
Very Positive	22.2	27.0	29.4	38.2	20.6	35.3	15.2	15.2	30.3	15.2
Positive	50.0	50.0	44.1	32.4	64.7	35.3	24.2	45.5	39.4	36.4
Neutral	25.0	11.1	23.5	20.6	14.7	23.5	21.2	33.3	30.3	21.2
Negative	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Very Negative	0.0	2.8	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Missing Values	2.8	2.8	0.0	0.0	0.0	0.0	39.4	6.1	0.0	24.2
Gamma	-0.0003		0.30		0.41		0.33		0.012	
Pearson's R	-8.09		0.23		0.26		0.28		0.10	
Significance	0.31		0.09		0.07		0.05		0.29	

In general, the study showed that attitudes play an important part in improving problem solving knowledge.

There was a high correlation between increases in positive attitudes and increases in problem solving knowledge. For the extremely positive the Gamma correlation between pre and post test is .82; for the very positive .65; for the positive 0.37; for the neutral .79; for the negative it was not possible to compile statistics since, the number of non-empty rows or columns is one.

The impact of change in attitudes on Problem Solving Knowledge measured by mid-term and final exam results shows improvement in the correlation for the experimental group (From -0.01 to .15 Gamma). The control group, however, reveals no change (Gamma from .12 to .12).

It is also important to realize that both the cognitive and affective approaches influence the change in attitudes. However, affective learning caused the greatest change in attitudes, followed by cognitive learning, while the combination between cognitive - affective was lowest.

Skills

Perceived need for developing problem solving skills was measured by 10 items. The subjects were asked to rate themselves for each of the items (see Page 16 of this study).

The skill need index is the sum of the 10 items (see Appendix I). The results revealed an increase in the skill need index as a consequence of taking problem solving courses

Skill Need index for Experimental Group and Control Group

	Experimental group		Control group	
	pre	post	pre	post
Very Low Need	0.0	0.0	0.0	0.0
Low Need	11.5	6.7	10.3	4.4
Average	67.3	47.1	48.5	30.9
Above Average	18.3	29.8	20.6	38.2
High Need	2.9	16.3	20.6	25.0
Gamma	.26		-0.08	

These results of the skill need index were unexpected, as the author observed an increase in the experimental group need perception for problem solving skills after taking the course. Indeed, those who considered their need as low, average or above average in the pre-test, consistently moved to a higher need perception in the post-test. Therefore, of those who considered their need as low at the beginning of the course, 11.3% responded that their need was higher at the end of the course.

Moreover, among those who considered the need for problem solving skills to be average in the pre-test, some 12.9% move to below average need and 31.4 to higher need in the post-test. This could be explained by the fact that taking problem solving courses increase students awareness of the need which was underestimated in the pre-test.

Perceived Need for Developing P.S. Skills

COUNT / ROW PCT / COL PCT / TOT PCT	POST-TEST Low Need	Average Need	Above Average Need	High Need	Row Total
PRE-TEST					
Low Need	0.0	9.0	1.0	2.0	12.0
	0.0	75.0	8.3	16.7	11.5
	0.0	18.4	3.2	11.8	
	0.0	8.7	1.0	1.9	
Average Need	5.0	34.0	22.0	9.0	70.0
	7.1	48.6	31.4	12.9	67.3
	71.4	69.4	71.0	52.9	
	4.8	32.7	21.2	8.7	
Above Average Need	2.0	6.0	5.0	6.0	19.0
	10.5	31.6	26.3	31.6	18.3
	28.6	12.2	16.1	35.3	
	1.9	5.8	4.8	5.8	
High Need	0.0	0.0	3.0	0.0	3.0
	0.0	0.0	100.0	0.0	2.9
	0.0	0.0	9.7	0.0	
	0.0	0.0	2.9	0.0	
Column Total	7.0	49.0	31.0	17.0	104.0
	6.7	47.1	29.8	16.3	100.0

Gamma = 0.26454
Parson's R = 0.15850
Significance = 0.0540

The increase of need among the Control group was less significant than among the experimental group. (Gamma -0.08).

Comparing the three courses in the experiment CPSW ranked first in developing the need of Problem Solving Skill awareness (Gamma .52). The second course was CORT Thinking Gamma .33) followed by CPS (Gamma .17).

The correlations among the two sub-control groups were not significant (Gamma .06 and .04).

Pre vs Post Skill Need Index by Course

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Level of Need										
Very Low Need	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0
Low Need	11.1	5.6	17.6	0.0	5.9	14.7	2.9	5.9	18.2	3.0
Average	66.7	52.8	70.6	47.1	64.7	41.2	35.3	32.4	63.6	30.3
Above Average	19.4	27.8	8.8	29.4	26.5	32.4	26.5	38.2	15.2	36.4
High Need	2.8	13.9	2.9	23.5	2.9	11.8	35.3	2.6	3.0	30.3
Gamma	0.17		0.52		0.33		-0.06		-0.04	
Pearson's R	0.08		0.28		0.24		-0.06		-0.04	
Significance	0.32		0.05		0.09		0.38		0.39	

Creativity

Teaching people to think creativity is a controversial issue. At one end there are those who maintain that "nobody can teach anybody anything" (Wees 1971). If creativity is characterized as a natural human process motivated by strong human needs, there is no need for teaching it. At the other end there are those who believe that it is possible to teach people to think creatively (see for example Torrance 1972).

Measuring creativity is equally controversial. Many educational psychologists (Cronbach 1968; Elkind, Deblinger and Adler 1970) believe that the term "Creativity" is too value laden and should not be used to designate the kinds of behavior involved in studies of teaching people to think more creatively. Tests for creativity were directed to having subjects answer questions on batteries of psychological tests directed to performance, and assessing creatively from the results. But other works have moved heavily in the direction of assessing creative personality and creative behavior (Haefele 1962, 195: 207). In my experiment creativity and its measurement was used in a specific way within the context of its relationship to creative problem solving courses. What is measured here is "the ability to think more creatively". My interest is to determine the consequences of making students aware of their mental blocks" in creative thinking and in developing their ability to think more creatively.

Creative thinking at its best is characterized by emotional and irrational thinking (the principle of differed judgement). After this kind of thinking has occurred, however, it must be subjected to tests of logic (logical reasoning), rational organized thinking.

It is also important to mention the author's personal belief that in creativity, skills are involved, and skills of any kind can be taught and practiced to function very well.

Results of the five tests revealed that among the experimental subjects percentage for those who become more creative, increased consistently. These percentages are as follows: words test creativity 30.9%, picture test 23.9%, traits test 13.6%, personality check list 12.8% and finally the innovation index 20.8%.

In the control group the percentages were either lower or negative. For "words tests creativity" only 15.4 became more creative. For the "picture test" the percentage dropped to -9%, while in the Traits test it dropped to -9%, traits test it dropped to 6.7 %. There was no change in the personality checklist and only 6% for the innovation index.

Creativity Tests Pre vs Post Results for Experimental Group

		Words Hints to Creativity		Picture* Test		Traits* Test		Personality* Check List		Innovation Index	
		Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %
Highly Crea-tive	90-100	0.0	6.2							0.0	11.5
	80-99	0.0	7.2							0.0	4.2
	70-79	0.0	3.1							3.1	8.3
	60-69	0.0	8.2							8.3	17.7
	50-59	0.0	6.2							18.8	9.4
	Total		30.9	30.4	54.3	23.2	36.8	39.2	52.0	30.0	51.0
Less Crea-tive	40-49	3.1	14.4							17.7	14.6
	30-39	7.2	9.3							10.4	19.8
	0-29	89.7	45.4							41.7	14.6
	Total		100.0	69.1	69.6	45.7	76.8	63.2	60.0	40.2	
	Missing Values								7.8		

*For these tests there was no score, the categories were either highly creative or less creative.

Creativity Tests Pre vs Post Results for Control Group

		Words Hints to Creativity		Picture* Test		Traits* Test		Personality* Check List		Innovation Index	
		Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %	Pre %	Post %
Highly Cre-tive	90-100	0.0	0.0							0.0	0.0
	80-90	0.0	1.9							0.0	2.0
	70-79	0.0	5.8							2.0	6.0
	60-69	0.0	0.0							6.0	6.0
	50-59	0.0	7.7							12.0	12.0
Total			15.4	54.5	45.5	22.2	28.9	44.0	44.0	20.0	26.0
Highly Crea-tive	40-49	1.9	9.6							14.0	22.0
	30-39	7.7	19.2							10.4	19.8
	0-29	90.4	55.8							54.0	40.0
Total		100.0	84.6	45.5	54.5	77.8	71.1	56.0	38.0		
	Missing Values								18.0		

*For these tests there was no score, the categories were either highly creative or less creative.

Coders judgment on the three tests and the McGraw Hill creativity test supported the previous conclusion. The percentage of increase in creativity is higher for the experimental group compared with the control group

Became More Creative	Picture Test		Traits Test		Personality Check List		McGraw-Hill Creativity	
	Exp.	Cont.	Exp.	Cont.	Exp.	Cont.	Exp.	Cont.
YES	53.2%	27.1%	61.5%	45.8%	59.6%	56.9%	75.8%	60%
NO	46.8%	72.9%	38.5%	54.2%	40.4%	43.1%	24.2%	40%

Comparing the three courses indicated that for words tests creativity humanities course "CORT Thinking" ranked first (.45 Gamma). The CPS and CPSW courses were lower than even the Control samples. The Humanities Course also ranked first on the personality check list (.52 Gamma, compared with .38 for CPS and .35 for CPSW).

The Correlation between Pre vs Post-test on Creativity Controlling for Course. (Gamma measurement)

	Words Hints to Creativity	Picture Test	Traits Test	Personality Check List	Innovation Index	Rank Order Points
CPS	0.29	0.65	0.60	0.38	-0.04	1+3+2+1 =9
CPSW	0.30	0.57	0.67	0.35	0.30	2+1+3+1 +3=10
CORT	0.45	0.58	0.25	0.52	0.26	3+2+1+3 +2=11
Control Sample 1	0.33	-0.03	0.13	-0.04	0.29	
Control Sample 2	0.35	0.10	0.27	0.40	0.26	

CPSW ranked first for the traits test (.67 Gamma) followed by CPS .60 Gamma). As for picture test CPS ranked first (.65 Gamma) followed by Humanities CORT Thinking (.58 Gamma). On the Innovation index CPSW ranked first (Gamma .30) followed by humanities CORT Thinking (Gamma.26).

Ranking these courses in terms of their contribution of developing creative thinking would give the Humanities CORT Thinking "11" points, CPSW "10" points and finally CPS "9" points.

Aptitudes

Results of the data revealed that only 18% (N.17) of the experimental subjects improved their pre-post aptitudes test index. Out of those subject 1.9% (N.2) scored high on the aptitude index. In the control group there was no increase, 4.4% decreased in the pre- vs. post aptitude score index (see next table).

Results seem to indicate that creative problem solving courses has less impact in changing aptitudes.

Aptitude Index
Pre vs. Post Tests for Experimental and Control Groups

Sample / Results	Experimental Group		Control Group	
	Pre	Post	Pre	Post
High	0.0	1.9% 2.0	0.0	0.0
Average	1.0 1.0	15.0% 16.0	4.4 3.0	0.0
Low	99.0 104.0	82.9% 87.0	%95.6 65.0	100.0 68.0
Total	100.0 105.0	100.0 105.0	%100.0 68.0	%100.0 68.0
Gamma Pearson's R	-1.00 -0.042		Statistics cannot be computed when the number of non-empty rows or columns is one.	

To find out which course contributed most to the increase of aptitudes among the experimental subject cross tabulation of the Post Aptitude index by course was completed. The data revealed that the CPS course ranked first followed by the CORT Thinking course which ranked second.

Pre-aptitude Index by Course

Count Row PCT Col PCT Tot PCT	Medium Aptitude Index	Low Aptitude Index	
CPS	1.0	36.0	37.0
	2.7	97.3	
	100.0	34.6	35.2
		34.3	
CPSW	0.0	34.0	34.0
	0.0	100.0	
	0.0	32.7	32.4
	0.0	32.4	
Humanities	0.0	34.0	34.0
De Bono	0.0	100.0	
	0.0	32.7	32.4
	0.0	32.4	
	1.0	104.0	105.0
	1.0	99.0	100.0

Aptitude Index Post-Test by Courses

COUNT / ROW PCT / COL PCT / TOT PCT		High Aptitude Index	Medium Aptitude Index	Low Aptitude Index	Row Total
CPS Champlain	1	2.0	6.0	29.0	37.0
		5.4	16.2	78.4	35.2
		100.0	37.5	33.3	
		1.9	5.7	27.6	
CPSW Champlain	2	0.0	5.0	29.0	34.0
		0.0	14.7	85.3	32.4
		0.0	31.3	33.3	
		0.0	4.8	27.6	
Humanities De Bono	3	0.0	5.0	29.0	34.0
		0.0	14.7	85.3	32.4
		0.0	31.3	33.3	
		0.0	4.8	27.6	
Column Total		2.0	16.0	87.0	105.0
		1.9	15.2	82.9	100.0

Aptitude index
Pre vs. Post for Creative Problem Solving Courses

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	0.0	5.4	0.0	0.0	-	0.0	-	0.0	-	0.0
Average	2.7	16.2	0.0	14.7	0.0	14.7	2.9	0.0	6.1	0.0
Low	97.3	78.4	100.0	85.3	100.0	85.3	97.1	100.0	93.9	100.0
Gamma	-1.00		-		-		-		-	
Pearson's R	-0.08		-		-		-		-	
Significance	0.32		-		-		-		-	

The aptitude index is composed of five tests: reasoning, number series, figure classification, verbal analogies and comprehension.

Comparing the results of the experimental group with the Control group on each of these tests reveals some improvement in aptitudes as a consequence of taking problem solving courses. The most noticeable change occurs in reasoning (Gamma 0.54) followed by number series Gamma .44) and verbal analogy (Gamma .22). The weakest change was in figure classification (Gamma 10) and comprehension (Gamma .03). As for reasoning, comparing the experimental group with the control group reveals significant improvement. The percentage for the experimental group who were rated low on reasoning dropped from 95% to 45.7% compared with a drop from 95% to 76.3% for the control group.

The same pattern is observed for verbal analogy and number series. The percentage for verbal analogy dropped from 89.6 on the low score to 69.8% for number series (operational analysis) the percentage of the low dropped from 25.6% to 17.9%

There was no significant change in the Control Sample regarding verbal analogy and number series (operational analysis).

With regard to reasoning the author found that within the experimental group the CPS Course ranked first in improving reasoning: 62.2, followed by CPSW at 47%, and finally CORT Thinking at 35,3. It should be noted here that CORT Thinking was ahead of CPSW with regard to the higher category of reasoning.

As for verbal analogy CPS ranked first (27%) followed by CORT Thinking (20.1) and finally CPSW (12%).

Finally with regard to number series CPSW ranked first (14.7%) followed by CPS 8.11). The CORT Thinking course did not have any impact on number series (operational analysis). The negative results could be due to the process variables.

Reasoning
Pre- vs Post-tests Results for Sub-samples (Courses)

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	0.0	32.4	0.0	8.8	0.0	14.7	0.0	11.4	0.0	0.0
Average	2.7	32.4	5.9	44.1	8.8	29.4	5.7	25.7	6.1	12.1
Low	97.3	35.1	94.1	47.1	91.2	55.9	94.3	62.9	93.9	87.9
Correlation Gamma	0.04		0.68		0.78		0.13		1.00	

Operational Analysis
Number Series
Pre- vs Post-test Results for Sub-samples

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	54.1	48.6	58.8	52.9	67.6	52.9	11.4	17.1	45.5	36.4
Average	16.2	29.7	11.8	32.4	14.7	20.5	2.9	17.1	21.2	18.2
Low	29.7	21.6	29.4	14.7	17.6	26.5	85.7	65.7	33.3	45.5
Gamma	0.23		0.47		0.66		0.55		0.14	

Figure Classification
Pre- vs Post-test Results for Sub-samples

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	-	8.1	2.9	0.0	0.0	5.9	0.0	0.0	0.0	0.0
Average	16.2	8.1	8.8	14.7	5.9	5.9	0.0	0.0	3.0	3.0
Low	83.8	83.8	88.2	85.3	94.1	88.2	100.0	100.0	97.0	97.0
Gamma	-0.04		0.41		-1.00		-		0.18	

Verbal Analogy
Pre- vs Post-test Results for Sub-samples

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	0.0	16.2	-	2.9	0.0	8.8	2.9	0.0	0.0	0.0
Average	13.5	24.3	11.8	20.6	5.9	17.6	2.9	14.3	0.0	3.0
Low	86.5	59.5	88.2	76.5	94.1	73.5	94.3	85.7	100.0	97.0
Gamma	0.21		0.03		0.30		0.13		-0.09	

Comprehension
Pre- vs Post-test Results for Sub-samples

Course	CPS		CPSW		CORT Thinking		Control Group 1		Control Group 2	
Result	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
High	5.4	16.2	2.9	5.9	5.9	2.9	0.0	0.0	9.1	0.0
Average	32.4	16.2	20.6	8.8	14.7	14.7	2.9	2.9	27.3	6.1
Low	62.2	67.6	76.5	85.3	79.4	82.4	97.1	97.1	63.6	93.9
Gamma	-0.02		-0.10		0.004		-0.09		-0.18	

The Correlation between Pre- vs Post Aptitude Tests Controlling for Course Measured by Gamma

	Reasoning	Number Series	Figure Classification	Verbal Analogy	Comprehension	Aptitude Index
CPS	0.04	0.23	-0.04	0.21	-0.02	-1.00
CPSW	0.68	0.47	0.41	0.03	-0.10	-
CORT	0.78	0.66	-1.00	0.30	0.004	-
Experimental	0.54	0.44	0.10	0.22	0.07	-1.00
Total Control Group	0.70	0.38	-1.00	1.00	0.32	-
Control 1	0.13	0.55	-	0.13	-0.07	-
Control 2	1.00	0.14	0.18	-0.09	-0.18	-

Process Variables and Experiential Variables

The change in students problem solving knowledge, procedures, skills, attitudes, creativity and aptitudes is not determined only by what is presented to the student, but also by how the subject matter is presented. This is the process variables and the experiential variables. The way the courses in problem solving are taught has an impact on the problem solving knowledge and skills.

Concerning the process variables the data indicates some difference between the experimental group and the control group. Students in problem solving courses tend to rate the ten variables dealing with the process mainly in the category high to very high. The percentage in these two categories tends to be higher than the control group. For example, 42.9 of the experimental group felt that the course format and content met the needs of the class, compared with 17.6 in the control sample. The following table contains the results for the remaining variables.

The Process and Experiential Variables by Experiential Control Groups

The Process Variables		Experimental	Control
(1)			
Degree to which course format and content meet needs of the class	VH	48.0	4.4
	H	38.1	13.2
	A	36.2	26.5
	L	10.5	11.8
	VL	1.0	0.0
	Missing	9.5	44.1
(2)			
Extent to which tone and pace were comfortable for the group		12.6	10.5
		44.2	42.1
		30.5	23.7
		11.6	21.1
		1.1	2.6
(3)			
Degree to which expectations of amount of skill development were met in class		5.3	0.0
		39.4	39.5
		41.5	50.0
		12.8	10.5
		1.1	0.0
(4)			
Ability of the instructor to track and describe accurately methods and styles of problem solving		28.7	18.4
		48.9	44.7
		18.1	23.7
		3.2	7.9
		1.1	5.3
(5)			
Extent to which the instructor helped to generalize course principles to actual work setting		18.1	7.9
		54.3	55.3
		27.7	23.7
		0.0	13.2

(6)			
Degree of openness, spontaneity, humor and energy exhibited by the instructor		53.7 35.8 10.5 0.0	44.7 36.8 13.2 5.3
(7)			
Degree of consistency between the instructor's style and material and exercises presented		21.1 58.9 17.9 2.1	7.9 47.4 39.5 5.3
(8)			
Ability of the instructor to assist individuals in formulating their own solutions		15.8 56.8 22.1 3.2 2.1	13.5 43.2 32.4 10.8 0.0
(9)			
Extent to which the instructor fielded responses and questions of class members with sensitivity and respect		25.3 50.5 18.9 2.1 3.2	18.4 50.0 28.9 2.6 0.0
(10)			
Degree to which the instructor encouraged group cohesiveness, trust and responsiveness	VH	25.3 53.7 17.9 2.1 1.1	27.0 45.9 24.3 0.0 2.7

Comparing the three courses under the study in terms of the process reveals that following results:

CPS students rated highest in accordance with the degree to which the course format and content met the needs of the class with 86.4, followed closely by CORT at 82.3 and lastly CPSW was 52.9. The controls could not be compared due to a high number of missing values.

With regard to the extent to which the tone and pace were comfortable for the group, CORT students rated highest with 80, followed closely by CPS at 77. CPSW and the control samples differed only slightly.

CORT ranked highest in the degree to which expectations of skill development were met in class at 91.1 as compared to 80 in CPS and 70 in CPSW.

The ability of the instructor to track and describe methods and styles of problem solving varied only slightly among the three courses under study with CPSW at 73.3, CORT at 66.6 and CPS at 61.8. The same applies to the extent to which the instructor helped generalize course principles to the actual work setting. CPSW ranked highest at 86.2, followed by CORT at 83.4 and CPS at 77.1. The control samples showed a decidedly higher number, however, illustrating perhaps that PS students have difficulty in conceptualizing PS role in future careers.

The degree of openness, spontaneity, humor and energy exhibited by the instructor was extremely high in each class with CPS at 91.4, CORT at 90 and CPSW at 86.7.

The degree of consistency between the instructor's style and material presented was identical for CPSW and CORT at 83.3. CPS, however, observed a tendency towards higher with 31.4 rating very high. Exactly the same applies to the instructor's ability to assist individuals in formulating their own solutions.

The extent to which the instructor fielded questions and responses with sensitivity and respect differed only marginally with CORT at 80, CPS at 74.3 and CPSW at 73.7. The degree to which the instructor encouraged group cohesiveness, trust and responsiveness was highest in CORT at 83.3. CPS was 80 and CPSW 73.3.

The Process and Experiential Variables by Course

The Process Variables

		CPS %	CPSW %	CORT %	CONT-ROL 1 %	CONT-ROL 2 %
(1)						
Degree to which the course format and content met the needs of class	VH	2.7	11.8	0.0	5.7	3.0
	H	40.5	29.4	44.1	14.3	12.1
	A	45.9	23.5	38.2	20.0	33.3
	L	5.4	17.6	8.8	5.7	18.2
	VL	0.0	2.9	0.0	0.0	0.0
	Missing	5.4	14.7	8.8	54.3	33.3
(2)						
Extent to which tone and pace were comfortable for the group		14.3	6.7	16.7	6.3	13.6
		40.0	43.3	50.0	50.0	36.4
		37.0	23.3	30.0	18.8	27.3
		8.6	23.3	3.3	25.0	18.2
		0.0	3.3	0.0	0.0	4.5
(3)						
Degree to which expectations of amount of skill development were met in class		8.6	6.7	0.0	0.0	0.0
		31.4	33.3	53.2	50.0	31.8
		48.6	36.7	37.9	43.8	54.5
		11.4	20.0	6.9	6.3	13.6
		0.0	3.3	0.0	0.0	0.0
(4)						
Ability of the instructor to track and describe accurately methods and styles of problem solving		35.3	16.7	33.3	25.0	13.6
		50.0	43.3	53.3	37.5	50.0
		11.8	30.0	13.3	18.8	27.3
		0.0	10.0	0.0	6.3	9.1
		2.9	0.0	0.0	12.5	0.0
(5)						
Extent to which the instructor helped to generalize course principles to actual work setting		22.9	13.8	16.7	0.0	13.6
		51.4	55.2	56.7	68.8	45.5
		25.7	31.0	26.7	13.8	27.3
		0.0	0.0	0.0	12.5	13.6

(6)						
Degree of openness, spontaneity, humor and energy exhibited by the instructor	VH	71.4	36.7	50.0	43.8	45.5
	H	20.0	50.0	40.0	31.3	40.9
	A	8.6	13.3	10.0	12.5	13.6
	L					
	VL	0.0	0.0	0.0	12.5	0.0
	Missing					
(7)						
Degree of consistency between the instructor's style and the material and exercises presented		31.4	13.3	16.7	6.3	9.1
		51.4	53.3	73.3	43.8	50.0
		14.3	30.0	10.0	37.5	40.9
		2.9	3.3	0.0	12.5	0.0
(8)						
Ability of the instructor to assist individuals in formulating their own solutions		22.9	6.7	16.7	13.3	13.6
		45.7	63.3	63.3	33.3	50.0
		22.9	23.3	20.0	40.0	27.3
		5.7	3.3	0.0	13.3	9.1
		2.9	3.3	0.0	0.0	0.0
(9)						
Extent to which the instructor fielded responses and questions of class members with sensitivity and respect		34.3	20.4	20.0	12.5	22.7
		40.0	53.3	60.0	56.3	45.5
		20.0	16.7	20.0	25.0	31.8
		2.9	3.3	0.0	6.3	0.0
		2.9	6.7	0.0	0.0	0.0
(10)						
Degree to which the instructor encouraged group cohesiveness, trust and responsiveness		34.3	20.0	20.0	13.3	36.4
		45.7	53.3	63.3	53.3	40.9
		17.1	23.3	13.3	26.7	22.7
		0.0	3.3	3.3	0.0	0.0
		2.9	0.0	0.0	6.7	0.0

Experiential Variables

The comparison between the Experiential and Control group revealed that students enrolled in the CPS courses tend to rate their experiences higher than the control sample. The following are the results in percentages

Experiential Variables		Experimental	Control
(1)		%	%
Degree of clarity and organization	VH	8.6	2.6
	H	54.8	44.7
	A	29.0	36.8
	L	6.5	10.5
	VL	1.1	5.3
(2)			
Amount of learning		10.5	1.5
		46.7	27.9
		25.7	14.7
		5.7	11.8
		1.0	0.0
		10.5	44.1
(3)			
Extent of enjoyment		20.2	10.5
		39.4	52.6
		30.9	23.7
		6.4	13.2
		3.2	0.0
(4)			
Degree of value for, and relevance to the actual or future work setting		14.0	5.4
		39.8	45.9
		38.7	35.1
		6.5	13.5
		1.1	0.0
(5)			
Ability of the instructor to direct and process the activity of the class		20.2	13.2
		53.2	47.4
		23.4	31.6
		2.1	7.9
		1.1	0.0

The extent to which students agree that the information presented was clear are as follows: CORT thinking ranked first at 89.7, followed by CPS at 79.4. The drop to CPSW is dramatic in comparison with the other two courses with a rating of 70. the two controls also varied greatly.

The value for information presented also varied. CPS was 73.5, CORT 63.4 and CPSW 53.3.

With regard to the degree to which the course met the needs of the class, there was little difference in the PS courses. The teacher's energy, humor and openness was also consistent. The degree to which the instructor encouraged group cohesiveness, trust and responsiveness was 70.5 in CPS, 70 in CPSW and 66.7. This shows a definite notable consistency. In each question involving a judgment of the instructor's abilities and conduct, the students of PS rated higher than the control samples.

Experiential General Evaluation

		CPS	CPSW	CORT	CONTROL 1	CONTROL 2
(1)						
Degree of clarity and organization	VH	8.8	6.7	10.3	0.0	4.5
	H	58.8	53.3	51.7	50.0	40.9
	A	23.5	30.0	34.5	31.3	40.9
	L	5.9	10.0	3.4	31.8	40.9
	VL	2.9	0.0	0.0	0.0	9.1
(2)						
Extent of enjoyment		20.6	16.7	23.3	12.5	9.9
		47.1	30.0	40.0	50.0	54.5
		23.5	40.9	30.0	25.0	22.7
		2.9	10.0	6.7	12.5	13.6
		5.9	3.3	0.0	0.0	0.0
(3)						
Degree of value for, and relevance to the actual or future work setting		11.8	13.3	17.2	6.7	4.5
		44.1	30.0	44.8	60.0	36.4
		35.3	53.3	27.6	20.0	45.5
		8.8	3.3	6.9	13.3	13.6
		0.0	0.0	3.4	0.0	0.0
(4)						
Ability of the instructor to direct and process the activity of the class		17.6	16.7	26.7	0.0	22.7
		64.7	43.3	50.0	50.0	45.5
		8.8	40.0	23.3	37.5	27.3
		5.9	0.0	0.0	12.5	4.5
		2.9	0.0	0.0	0.0	0.0

General Evaluation

The degree of clarity and organization differed only slightly in the three experimental variables with CORT at 86.2, CPSW at 83.3 and CPS at 82.3. The controls were also high at 81.3 and 81.8.

The extent of enjoyment did not vary greatly. CPSW rated 70.9, CPS was 70.6 and CORT was 70. The controls rated their classes as more enjoyable at 75 and 77.2.

The degree of value and relevance to the actual work setting varied greatly from 83.3 in CPSW to CPS at 79.4 and 72.4 in CORT. The controls rated a higher degree of value for the future at 80 and 81.9.

Students seem to feel that the greatest amount of learning is obtained in the CPSW and CORT classes. The rated 66.7 and 66.6. CPS at 64.7 shows little difference. The controls ranked much more highly in one class, and a great deal lower than the PS classes in the other.

CORT ranked most enjoyable at 68.6, while CPS was 64.7 and CPSW was 60. Again, one control was on the average higher, and the other lower.

The classes felt that CPS had the most relevance to life at 52.9 followed by CORT at 43.3 and CPSW at 40. The controls ranked lower on the average.

Summary - General Evaluation

		EXPERIMENTAL CPS/CPSW/CORT	CONTROLS
CONTENT:			
The extent to which I understood the information presented	VH	6.4	10.5
	H	37.2	21.1
	A	33.0	42.1
	L	19.1	18.4
	VL	2.1	5.3
		2.1	2.6
The extent to which I agreed with the information presented		3.2	2.6
		38.7	31.6
		40.9	28.9
		10.9	31.6
		4.3	2.6
		2.2	2.6
The extent to which I valued the information presented		5.3	8.1
		31.9	18.9
		31.9	32.4
		20.2	29.7
		5.3	10.8
		5.3	0.0
PROCESS			
The degree to which the course met the needs of the class		2.2	0.0
		29.0	13.2
		36.6	34.2
		24.7	34.2
		7.5	15.8
		0.0	2.6
The degree of openness, spontaneity, humor and energy exhibited by the instructor		30.9	26.3
		47.9	39.5
		14.9	21.1
		4.3	10.5
		1.1	2.6
		1.1	0.0
The degree to which the instructor encouraged group cohesiveness, trust and responsiveness		19.1	21.1
		43.6	39.5
		25.5	21.1
		9.6	13.2
		1.1	2.6
		1.1	2.6

EXPERIENCE		
The amount of learning I experienced in this course	3.2	5.3
	26.7	21.1
	37.2	39.5
	17.2	18.4
	9.6	10.5
	4.3	5.3
The extent of enjoyment I experienced in this course	10.8	7.9
	33.3	31.6
	28.0	28.9
	18.3	21.3
	3.2	5.3
	4.3	0.0
	2.2	0.0
THE PROCESS VARIABLES		
The extent to which the course was relevant to my life	6.4	7.9
	23.4	10.5
	22.3	28.9
	26.6	21.1
	12.8	15.8
	4.3	13.2
	4.3	2.6

General Evaluation

		CPS	CPSW	CORT	CONTROL 1	CONTROL 2
CONTENT						
The extent to which I understood the information presented	High 7	5.9	6.7	6.7	12.5	9.1
	H6	29.4	50.0	33.3	18.8	20.7
	H5	44.1	20.0	33.3	43.8	40.9
	A4	17.6	16.7	23.3	18.8	18.2
	A3	0.0	3.3	3.3	6.3	4.5
	A2	2.9	3.3	0.0	0.0	4.5
The extent to which I agreed with the information	H7	2.9	6.7	0.0	0.0	4.5
	H6	38.2	36.7	41.4	31.3	31.8
	H5	41.2	33.3	48.3	37.5	22.7
	A4	11.8	10.0	10.3	31.3	31.8
	A3	2.9	10.0	0.0	0.0	4.5
	A2	2.9	3.3	0.0	0.0	4.5
The extent to which I valued the information presented		0.0	13.3	3.3	13.3	4.8
		29.4	30.0	36.7	26.7	13.6
		44.1	23.3	26.7	40.0	27.3
		14.7	16.7	30.0	20.0	36.4
		5.9	10.0	0.0	0.0	18.2
		5.9	6.7	3.3	0.0	0.0
PROCESS						
The degree to which the course met the needs of the class		2.9	0.0	3.3	0.0	0.0
		29.4	31.0	26.7	12.5	13.6
		32.4	37.9	40.0	43.8	27.3
		26.5	20.7	26.7	31.3	36.4
		8.8	10.3	3.3	12.5	18.2
		0.0	0.0	0.0	0.0	4.5
The degree of openness, spontaneity, humor and energy exhibited by the instructor		21.5	30.0	36.7	18.8	31.8
		52.9	43.3	46.7	31.3	45.5
		8.8	20.0	16.7	25.0	18.2
		8.8	3.3	0.0	18.8	4.5
		2.9	0.0	0.0	6.3	0.0
		0.0	3.3	0.0	0.0	0.0

THE PROCESS VARIABLES

The degree to which the		23.5	13.3	20.0	6.3	31.8
instructor encouraged group		52.9	40.0	36.7	43.8	36.4
cohesiveness, trust and		17.6	26.7	33.3	18.8	22.7
responsiveness		2.9	16.7	10.0	25.0	4.5
		0.0	3.3	0.0	6.3	0.0
		2.9	0.0	0.0	0.0	4.5

EXPERIENCE

The amount of learning		2.9	3.3	3.3	6.3	4.5
I experienced		26.5	26.7	33.3	31.3	13.6
		38.2	40.0	33.3	43.8	36.4
		14.7	13.3	23.8	6.3	27.3
		11.8	10.0	6.7	12.5	9.1
		5.9	6.7	0.0	0.0	9.1
The extent of enjoyment		5.9	10.0	17.2	6.3	9.1
I experienced in this course		35.3	30.0	34.5	31.3	31.8
		29.4	30.0	24.1	37.5	22.7
		20.6	10.0	24.1	18.8	31.8
		0.0	10.0	0.0	6.3	4.5
		5.9	6.7	0.0	0.0	0.0
	L1	2.9	3.3	0.0	0.0	0.0
The extent to which the		2.9	10.0	6.7	6.3	9.1
course was relevant to my		23.5	23.3	23.3	18.8	4.5
life was:		29.4	16.7	20.0	18.8	36.4
		23.5	30.0	26.7	25.0	18.2
		8.8	16.7	13.3	25.0	18.2
		2.9	0.0	10.0	6.3	18.2
	L1	8.8	3.3	0.0	0.0	4.5

Impact on Academic Performance

To what extent does taking Creative Problem Solving courses influence the academic performance of the students? Do the students in the experimental groups as compared with those in the control groups show a significant improvement in their overall average for the semester in which they took part in the research, compared to their previous semester's record? Would they show improvement in other courses of a

problem solving nature such as: math, physics, chemistry, computer science, economics.

Significant differences were noted between the average that students obtained during the previous semesters (overall average in college) as compared to the semester in which they are enrolled in CPS courses. (Gamma for the experimental group 0.79 compared with .69 for the control group).

Correlation of average in the current semester with previous semesters (average in College) measured by gamma for experimental group

Average in Current Semester

COUNT ROW PCT COL PCT TOT PCT		90-100%	80-90%	70-79%	60-69%	59 OR LESS	ROW TOTAL
90-100% OUTST	1	1.0	0.0	0.0	0.0	0.0	1.0
		100.0	0.0	0.0	0.0	0.0	1.3
		50.0	0.0	0.0	0.0	0.0	
		1.3	0.0	0.0	0.0	0.0	
80-90% VERY G	2	0.0	8.0	1.0	0.0	0.0	9.0
		0.0	88.9	11.1	0.0	0.0	11.7
		0.0	44.4	2.2	0.0	0.0	
		0.0	10.4	1.3	0.0	0.0	
70-79% GOOD	3	1.0	9.0	38.0	4.0	1.0	53.0
		1.9	17.0	71.7	7.5	1.9	68.8
		50.0	50.0	82.6	40.0	100.0	
		1.3	11.7	49.4	5.2	1.3	
60-69% SATISF.	4	0.0	1.0	7.0	6.0	0.0	14.0
		0.0	7.1	50.0	42.9	0.0	18.2
		0.0	5.6	15.2	60.0	0.0	
		0.0	1.3	9.1	7.8	0.0	
COLUMN TOTAL		2.0	18.0	46.0	10.0	1.0	77.0
		2.6	23.4	59.7	13.0	1.3	100.0

CONDITIONAL GAMMA = 0.79317
PEARSON'S R = 0.53912
SIGNIFICANCE = 0.0000

Correlation of average in the current semester with previous semesters (average in college) measured by Gamma for control group

Average in Current Semester

COUNT / ROW PCT / COL PCT / TOT PCT		90-100%	80-90%	70-79%	60-69%	ROW TOTAL
AVERAGE IN PREVIOUS SEMESTER						
80-90% VERY G	2	0.0	5.0	1.0	0.0	6.0
		0.0	83.3	16.7	0.0	13.6
		0.0	41.7	4.0	0.0	
		0.0	11.4	2.3	0.0	
70-79% GOOD	3	1.0	6.0	20.0	3.0	30.0
		3.3	20.0	66.7	10.0	68.2
		100.0	50.0	80.0	50.0	
		2.3	13.6	45.5	6.8	
60-69% SATISF.	4	0.0	1.0	4.0	3.0	8.0
		0.0	12.5	50.0	37.5	18.2
		0.0	8.3	16.0	50.0	
		0.0	2.3	9.1	6.8	
COLUMN TOTAL		1.0	12.0	25.0	6.0	44.0
		2.3	27.3	56.8	13.6	100.0

CONDITIONAL GAMMA = 0.69427
PEARSON'S R = 0.43560
SIGNIFICANCE = 0.0016

The following results were obtained when the students overall academic improvement was considered as a function of taking problem solving courses:

CPS ranked first (Gamma 0.94) followed by CPSW (Gamma 0.88). The humanities CORT Thinking ranked third (Gamma 0.69). The control sample correlation was only Gamma 0.53.

That CPS courses have an impact on the overall averages of students can be explained by the teaching of the learning requirements for problem solving. Learning requirements include time management and planning, making and keeping connection (the human mind and memory) and finally study and learning skills. It is important to note here that this improvement could be due to other course components as well.

Significant differences were also noted between the averages students obtained in problem solving courses and those they got in courses of a problem solving nature taken during previous semesters. The correlation for the experimental group were (.59 Gamma) compared with (.15 Gamma) for the control group.

A comparison of the three different courses shows that CPSW ranked first with (.82 Gamma) correlation, CPS ranked second with (.52 Gamma) correlation. The humanities CORT Thinking ranked third (.49 gamma). The control group correlation was only .12 Gamma.

Conclusion

The creative problem solving program under evaluation can be viewed as a behavior modification program in which the desired behavioral outcome, that is, effective and creative problem solving, is achieved. The study evaluates three courses in creative and applied problem solving. The subjects were CEGEP students who had attended these three different courses at Champlain Regional College, St. Lambert Campus, Quebec. All of these experimental subjects were tested before and after taking the courses with a set of recognized tests. These tests measured the following:

1. Content variables which deals with:

   - Problem solving knowledge
   - Problem solving strategies (procedures)
   - Attitudes towards PS and creativity
   - Creativity
   - Aptitudes

2. Process variables which measure and evaluate the effectiveness and structuring format of the courses under evaluation.

3. The experimental variables which measure and evaluate the experiences students gained during the courses.

Differences in experimental subjects in their pre- and post-training test scores were obtained and compared with variations in test scores for two control groups.

It was hypothesized that course effects would be manifested in an increase and change in the positive direction in students' knowledge of problem solving and PS strategy, skills, attitudes, aptitudes and creativity. This major hypothesis was supported. Problem solving courses did increase scores on all tests significantly.

The measures for problem solving knowledge showed scores in a positive direction: for CPS Gamma was .79 and Pearson's R 0.39 - Significance .009; for CPSW Gamma was 1.00 and Pearson's R 0.31 - Significance .05; for CORT Thinking Gamma was .31 and Pearson's R .08 - Significance .32.

The measurements for problem solving strategies (procedures) also showed scores in the positive direction for the experimental group; Gamma was .38, Pearson's R .19 - Significance 0.02. The correlation for the control group was negative; Gamma -.09, Pearsons's R -.12 - Significance .17. The same pattern reveals for each course involved with varying degrees of correlations and significance. As for each step in problem solving procedures the correlation measured by Gamma between pre- and post-tests was significant for problem identification (E .06 Gamma, C -.04 Gamma)"; selection of alternatives (E .35, C .17) and rationalization and implementation (E .20, C -.78)

Measures for attitudes towards problem solving and creativity showed scores in the positive direction (Gamma .47, Pearson's R .36 -

" "E" for experimental group and "C" for control group.

Significance .0002). As for attitudes towards problem solving courses (Gamma .41, Pearson's R .22 - Significance .01).

The skill need index measures showed scores in the positive direction. These results were unexpected. It was expected that students need perception would be lower in the post-test. The contrary was true with Gamma correlation of .26 for the experimental group and -.08 for the control group.

Five measures of aptitude showed scores in the positive direction: reasoning, number series or operational analysis, figure classification, verbal analogy and comprehension. The differences were of a borderline statistical significance in favor of the experimental groups. The most notable change occurred in reasoning (Gamma .54) followed by number series (Gamma .44) and finally verbal analogy (Gamma .22). The change in figure classification (Gamma .16) and comprehension (Gamma .07) were very weak.

The second hypothesis was supported only by percentages. Students enrolled in the creative problem solving courses showed improvement on the creativity and innovation index tests. The statistical significance was slightly higher for the control group.

The third hypothesis was supported by the data. Students enrolled in CPS courses tended to rate their experience higher than those who did

not take the courses. They also tended to rate the process variables and the way the course was conducted higher than the control group.

The fourth hypothesis was not supported by the data. Each approach revealed a different impact on the variables involved: cognitive approach was most effective in teaching problem solving knowledge (Gamma.79) and problem solving strategies (procedures) (Gamma .36). The affective approach had the most impact on changing attitudes towards problem solving (Gamma .68) and PS courses (Gamma .41). The impact of the affective approach on creativity was also noticeable especially for the test words hints creativity (.45) and personality traits test (.52). Its impact on procedures was mainly on evaluation (.19). It ranked second on influencing attitudes towards PS courses.

This means that the choice of the teaching approach depends on the main objective desired by the instructor. If it is knowledge and strategies then the cognitive approach is the most suitable. If the main objective is to improve attitudes and creativity the affective approach is the most suitable. The combination between affective and cognitive is the best for average improvement for all problem solving variables.

The fourth and fifth hypotheses were supported. Students enrolled in CPS courses showed significant improvement in their overall average for the semester in which they were enrolled compared with those of their previous semesters (Gamma for the experimental group 0.79 and for the control group 0.69). Those students also showed significant differences

in courses of a problem solving nature (Gamma for experimental group was .59 compared with .15 for the control group).

The seventh hypothesis was supported by the data. The change in attitudes had an impact on developing problem solving knowledge

Correlation of Pre- vs Post Measured by Gamma for Approach

	Cognitive	Affective	Combination
	CPS	CORT	CPSW
Problem Solving Knowledge	0.79	0.31	1.00
P.S. Procedures	0.36	0.30	0.24
- Identification	-0.06	0.16	0.02
- Alternatives	0.04	0.30	0.23
- Evaluation	-0.23	-0.11	0.19
- Selection	0.27	0.62	0.28
- Rationalization & Implementation	0.38	0.28	-0.11
Attitudes towards P.S.	0.33	0.68	0.12
Attitudes towards P.S. Courses	-0.003	0.41	0.30
Skills Index	0.17	0.33	0.52
Aptitudes Index	-1.00	-	-
- Reasoning	0.04	0.78	0.68
- Number Series	0.23	0.66	0.47
- Figure Classification	-0.04	-1.00	0.41
- Verbal Analogy	0.21	0.30	0.03
- Comprehension	-0.02	0.004	-0.10
Creativity			
- Words	0.29	0.45	0.30
- Picture	0.65	0.58	0.57
- Personality	0.38	0.52	0.35
- Traits	0.60	0.25	0.67
Innovation Index	-0.04	0.26	0.30

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