How to Teach IS Students to Be More Creative

J. Daniel Couger

INTRODUCTION

Formal creativity modules were specified in **I.S.'96: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems.**[1] The need for creativity was implicitly assumed in prior curriculum recommendations. It was made explicit in **I.S.'96** because CIOs around the U.S. rank the need high on their lists of key issues [2].

In a 1995 article in this journal [3], I explained the creativity content of **I.S.'96**. In that article, I described the "what" about creativity — what should be taught I.S. students. Since that time, I've been asked by a number of I.S. faculty about the "how" of teaching creativity. This article explains approaches of teaching creativity effectively.

In teaching those topics to I.S. students for more than a decade, I've experimented with a variety of approaches. Some didn't work very well! Over the decade, I've gradually evolved approaches to ensure that students learn, not only creativity principles and concepts, but how they can apply those fundamentals in real-life I.S. situations. The most effective learning approaches will be explained under the framework of: 1) acquiring the domain of knowledge about creativity and innovation and 2) applying that domain of knowledge to a wide range of I.S. activities.

ACQUIRING THE DOMAIN OF KNOWLEDGE

In **I.S.'96**, the domain of knowledge about creativity and innovation was classified under two broad headings: 1) creative problem solving and opportunity identification and 2) ensuring a positive environment for creativity. One might think the latter topic applies only to managers, and therefore, would be covered in an MBA program instead of an undergraduate program. To the contrary, my research on developing creativity improvement programs for I.S. organizations revealed that teams have a major impact on creativity of individuals. Key factors that affect the climate for creativity within the team setting need to be understood by undergraduates; they will be operating in a team environment immediately upon employment in the field.

I.S.'96 also specified competency levels for coverage of all topics. The Bloom taxonomy [4] was used, where the first two levels were essentially acquisition of knowledge and understanding and the next two levels reinforced this knowledge through its application. For example, the learning module of creative problem solving and opportunity identification is covered at four points in the undergraduate I.S. curriculum, at progressively greater levels of depth. The same approach applies to the learning module of ensuring a positive environment for creativity. However, as helpful as they are in course design, curriculum models are of little help in guidance to I.S. faculty on how topics are to be taught. Teaching approaches will be covered next.

TEACHING THE DOMAIN OF KNOWLEDGE

To a faculty member unfamiliar with the field of creativity and innovation, the domain of knowledge might appear somewhat nebulous. I've distilled that material into less than 100 pages [5]. The knowledge level of creativity concepts/principles can be satisfactorily acquired through reading assigned material and listening to lectures. The understanding level is attained through: 1) students asking themselves, as they read or listen to a description of the topic, how they might apply it to tasks in the I.S. field and 2) classroom exercises and mini-cases. I'll illustrate these exercises in the next section where I discuss the next two competency levels — application of the material.

APPLICATION OF THE MATERIAL

Optimal learning occurs when students try to think about applicability as they read about each topic. Since faculty have little control over student reading activity, they need to ensure understanding through assigned tasks and exercises. I've found two ways effective in reinforcing the reading/listening step in learning. First, classroom exercises demonstrate the validity of the approach and provide an elementary level of application. Second, students are assigned an exercise of applying what they've learned to an assignment in some **other** class they are taking. Here they must work independently, thus gain deeper understanding than through a team exercise in class.

The framework for creative problem solving (CPS) applies to every class being taken by the student. The five step CPS methodology is shown in Figure 1. The static CPS model has been around for a number of years. I converted the model to a methodology by identifying 22 creativity techniques appropriate for the I.S. field and showing how various techniques can be applied in each phase of the CPS process — not just in the idea generation phase. My earlier research located some 50 creativity techniques proven successful in other disciplines. I tested all of them in the I.S. environment and selected the 22 most appropriate for the I.S. field. The selection of the 22 chniques came through the process of experimentation first with students, then with S. practitioners.

The five CPS steps (problem definition, ata gathering, idea generation, evaluation and nplementation planning) apply to all prob-m solving situations. Typical applications of ne CPS methodology, covered progressively nrough the I.S. curriculum are: selecting a PC irst course in I.S.), choosing a programming nguage or designing a program (program-ning course), designing a database, developing computer application, selecting a technology latform. In the project management course, PS methodology also applies a variety of ays, beginning with development of the pro-ct plan, selection of project management ools, design of testing and implementation pproaches.

After my first three years of use of the CPS ethodology, I recognized that it applies qually well to opportunity delineation. For xample, a system team might have a policy of nnually reviewing development methodolo-y to determine if better approaches are avail-ble. The CPS process would be effective for entifying and evaluating new methodologies. Or, a technology assessment team will periodically explore the field to see if new technologies are now available to aid in a task not previously cost effective for automation. The CPS process would be effective for technology scanning.

HOW THE INDIVIDUAL CREATIVITY TECHNIQUES ARE USED WITHIN THE CPS FRAMEWORK

Let's examine how one might teach the CPS methodology through use of the various creativity techniques to operationalize each of the five CPS phases. One of the techniques listed under Phase 1, problem definition, is **Boundary Examination**. This technique is useful in questioning various frames of reference and assumptions about the problem or opportunity.

In Phase 2, gathering relevant information, the **Attributes Association** technique is useful. Examining the attributes of the problem ensures that the appropriate information about the problem is identified.

All 22 techniques are appropriate for the idea generation step, Phase 3. Ironically, the only techniques widely used in I.S. — **Brainstorming** — has been proven to be the least effective technique. **Brainwriting** has been shown to produce 50% more useful ideas while the **Nominal Group** technique produces 100% more useful ideas.

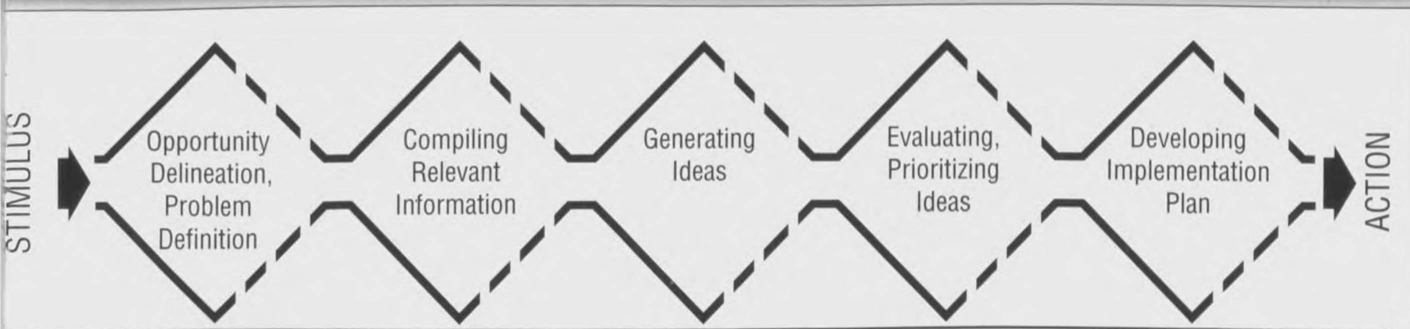
For Phase 4, evaluation and prioritization, some 11 evaluation techniques are available. Creativity techniques are useful in this phase, as well. One is the **Interrogatories** technique which asks questions beginning with the 5 Ws & H (who, where, when, why, what and how) to distinguish advantages from disadvantages of various ideas.

In Phase 5, implementation planning, **Force Field Analysis** can be used to identify the forces that will produce a successful implementation and the forces that push toward failure. The technique then derives actions that move the outcome from a catastrophic to an optimal result.

DISTINGUISHING THE TWO PRINCIPAL LEARNING MODULES

So far, I've described teaching approaches for the first of the two creativity- related learning module specified in **I.S.'96**, creative problem solving and opportunity identification. CPS applies in all I.S. activities, from data

igure 1: Creative Problem Solving Methodology



CREATIVITY TECHNIQUES

Opportunity Delineation, Problem Definition	Compiling Relevant Information	Generating Ideas		Evaluating, Prioritizing Ideas	Developing Implementation Plan
AA	AA	AA	MC	DI	BL
BE	BL	A/M	MV	DM	CBS
BL	5Ws/H	BL	NGT	LB	DI
LB	LB	BS	PA	FFA	5Ws/H
L/R	MV	BW	PR	PA	LB
MV		CBS	PS	PS	L/R
PA		5Ws/H	RS		PR
PR		GW	WI		
WI		LB	WT		
WT		L/R			

AA	Attribute Association	DI	Disjointed Incrementalism	MV	Manipulative Verbs
A/M	Analogies/Metaphors	DM	Decomposable Matrices	NGT	Nominal Group Technique
BE	Boundary Examination	5Ws/H	Interrogatories	PA	Progressive Abstraction
BL	Bug List	FFA	Force Field Analysis	PR	Problem Reversal
BS	Brainstorming	GW	Goal/Wish	PS	Peaceful Setting
BW	Brainwriting	LB	Lotus Blossum	RS	Role Storming
CBS	Crawford Blue Slip	L/R	L/R Brain Alternations	WI	Wild Idea
		MC	Morphological Connections	WT	Wishful Thinking

entry to CIO functions and from start to finish of any given task. That is why it should be taught beginning with the first I.S. course and then at increased levels of sophistication as students progress through the other courses. There are problems to be solved in all I.S. activities and the model facilitates their solution.

The same logic applies to opportunity identification. I.S. practitioners need to be seeking opportunities for improvement in all activities, if the U.S. is to maintain its international lead in software generation. One of the CIO participants in the Delphi survey expressed that problem quite well:"The U.S. has lost its lead in almost every competitive area. Innovative software previously gave our companies major competitive advantage and now even that area is threatened. I.S. must increase its creativity to help the U.S. regain its competitive edge."

Students in our I.S. programs need to understand the imperative for improving personal and team creativity. With this understanding they are more motivated to acquire a domain of knowledge about creativity and a proficiency in its application.

The team creativity aspect in the previous paragraph relates to the second learning module in the creativity curriculum specified in **I.S.'96**: ensuring a positive climate for creativity. The research shows that individual team members have significant impact on the team's climate for creativity. Ideally, the manager to whom the team reports is well aware of the key ingredients for positive environment for creativity and actively pursues the provision of those within his/her realm of responsibility. Those factors should be covered in the project management course in the I.S. curriculum.

Team members have equal responsibility for ensuring a positive climate for creativity. My research shows that more than half of the key factors affecting climate can be influenced by the team, irrespective of what the manager is doing.[6] Stated another way, a team reporting to a non-supportive manager can work together to produce a climate that is at least favorable, although not optimal, for creativity. When I ask teams in I.S. organizations to identify the factors they believe most influential in a positive climate, they typically identify some 20 - 30 factors. In the second step of the exercise, they identify the factors they believe they have the most influence over. They are usually surprised to recognize that they have the primary influence on more than half of the key factors. However, some factors have more impact than others, so prioritization is necessary, step three of the exercise .

The information on the set of factors and their relative importance needs to be a part of I.S. students' knowledge domain. Our research provides that information.[7] This information has its associated application, that students need for comprehensive understanding on how to produce a positive environment for creativity. Application most effectively occurs in team-related activities for students. Part of the project assignment can be the post mortem assessment of how well the team provided its own climate for creativity. The team understands climate factors better when it makes its own assessment, rather than have an outsider, such as a professor, make the assessment. The team should also evaluate the external factors — that is, the university and faculty support for creativity. This approach provides a complete learning experience. Other avenues for learning about climate are case studies and field trips to observe effective teams in action.[8]

Most colleges require a course of all business students on small group dynamics. These courses are typically offered to sophomore or juniors, so students have knowledge of good team practices before they take the I.S. courses that use teamwork extensively. If this type of course is not required of I.S. majors, **I.S.'96** includes the team-building topics to be included in required I.S. courses.

CONCLUSIONS

The need for creativity improvement throughout I.S. was identified in my 1988 Delphi study of CIOs. When asked to identify and rank the top 20 issues for the decade of the 1990s, CIOs rated the need for more creativity in 6th place. When the study was replicated in 1992, that issue had risen to 5th place in the ranking. It is enigmatic that I.S. has worn blinders about use of specific methodology for improving creativity. Blake Ives, editor of MIS Quarterly, expressed this enigma very well in his editorial summary of my article on creativity in the December, 1993 issue of that journal[9]: "System analysis and design books have a common shortcoming. They focus on analysis of the old system and documenting and implementing the new, but they give scant attention to conceptual design. Tom DeMarco noted in 1979, 'It is at this time [after analysis of the old system] that the analyst exercises his [or her] experience and imagination to come up with the new system concept...I won't tell you how to go about this...no tool that I could think of would aid the invention process.' Fourteen years later, Tom Davenport found himself at a similar loss for words in describing how to re-engineer business processes: 'Ironically, there is less to say about the design phase of process innovation than about the activities that lead up to it. The design activity is largely a matter of having a group of intelligent, creative people review the information collected in earlier phases of the initiative and synthesize it into a new process.'" Ives concludes: "How curious that this creative process, so fundamental to our profession, remains as unexplained, largely unexplored, and, to a large extent ignored."

This is the reason that the national curriculum committee, comprised of I.S. academicians and practitioners, chose to include explicit content about creativity in the national curriculum recommendations. Hopefully, this article will assist faculty in implementing those recommendations.

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J. Daniel Couger
Distinguished Professor, I.S. and Mgt Science
Director, Center for Research on Creativity and Innovation
University of Colorado, Colorado Springs
(719) 262-3403
DCouger@mail.uccs.edu

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