

Teaching Creativity and New Product Development in a distance learning environment

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Abstract - At the University of Virginia, we offer a highly successful course on Creativity and New Product Development to advanced undergraduates and graduate students. In 1999, this course was offered to students throughout Virginia in a distance-learning environment. We broadcast televised classes to sites around the state. Three types of students were enrolled; undergraduates and graduate students on campus, and graduate students at remote sites – all of whom worked full time. This course was offered in the evenings. In this paper, we review our experiences, problems and successes with conducting a project-oriented and team – based course with students distributed geographically. Seven projects were completed; and they varied in quality. But most students felt that the course worked in this mode, and would recommend it to a friend or coworker. We will offer it again in this medium. This paper highlights what worked, and what didn't.

Index terms - Creativity, new product development, distance learning, entrepreneurship.

Introduction

Creativity and New Product Development was originally developed at the University of Virginia by Henry Bolanos and Dave Lewis. Henry is an inventor and entrepreneur, and Dave is a mechanical engineer with extensive business experience. They proposed a course that would teach the new product development process by simulating it in class. Student teams would come up with ideas for new products, design and prototype a concept, develop a bill of materials and manufacturing plan, and prepare a financial analysis, a marketing strategy, and a business plan. Each team's final presentation for the course would be a briefing to a group of venture capitalists – appealing for funding for their new company. Each team was also expected to submit a disclosure document or provisional patent to the U.S. Patent and Trademark Office.

I assumed responsibility for this course in 1998, and have taught it three times so far. Dave Lewis has continued his involvement with the course despite his retirement. Henry Bolanos is an occasional visitor to the University of Virginia and guest lecturer. He also regularly teaches this

course at Yale, and at the University of Auckland, New Zealand.

Class objectives

There are no formal prerequisites for this course, and we attract students from diverse backgrounds and interests including business, engineering, liberal arts, social sciences, and commerce.

We have three general goals for the course: (1) to provide an overview of the basic processes in new product development in a competitive marketplace by simulating them in class, (2) to acquire the skills for successfully creating and developing a new product through hands-on, team-based projects, and (3) to become more creative individuals and more effective team members.

The topics covered in this class fall into four categories: technical skills, creative thinking, business strategies, and people skills. *Technical skills* focus on issues of product specification, concept selection, product architecture, modeling and documentation, bill of materials, prototyping (virtual and physical), manufacturing, and production planning. *Thinking creatively* explores how to generate ideas; how to elaborate concepts and alternatives; what psychologists, artists, engineers, and scientists know about creativity; and how to develop and foster, or stifle and kill, creativity. *Business strategies* include assessing customer needs; project scheduling; financial analysis; protecting your ideas; marketing, advertising, selling; and entrepreneurship. *People skills* involve team dynamics and roles; negotiating styles and strategies; appealing to the customer; understanding individual differences and preferences; and how to present your ideas effectively.

Class Format

In a typical class, the first day is devoted to generating ideas for projects. This is done in a brainstorming format: students suggest problems or needs that new products might be designed to meet. A complete list of all ideas is maintained during class, and distributed to all students after class. By the second class, each student has chosen several ideas to pursue (which might include new ideas that occurred outside

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of class). Any student with a strong interest in a particular idea can solicit team members to pursue that project. By the end of this class, we have established a set of topics and teams. The topics are problems to be solved, not pre-conceived solutions.

Each team must then develop a Mission Statement and a Gantt chart. During the semester, each team develops a series of design concepts to solve their problem, generates many alternatives, assesses customer needs, selects a final design, builds a prototype, generates a bill of materials and manufacturing plan, conducts a financial analysis, analyzes the competition, formulates a business plan and marketing strategy, conducts patent searches and prepares a patent, and makes several formal presentations about their product.

This is not a lecture class. We have some lecture/discussion sessions and guest speakers on patents, intellectual property, and venture capital. But, most class periods are devoted to team interactions with the professors observing, facilitating, and occasionally advising. We assign readings on new product development [1,2] and entrepreneurship [3], and suggest web resources on creativity, invention and design, modeling and prototyping, patents, and entrepreneurship.

Distance learning

Distance learning is now a critical component of the educational delivery system for many schools. At the University of Virginia, we have offered distance-learning programs since 1983 [4,5]. In 1999, we offered *Creativity and New Product Development* through the University of Virginia's Cooperative Graduate Education Program. Distance Learning courses have traditionally involved televised lectures and videotapes, but recently have we have made extensive use of the Internet and e-mail. For many classes, this type of distance-learning environment is fine. Indeed, the instructor often does a better job on television, and covers more material than in a traditional classroom. He or she is forced to organize the material and to prepare extensively in advance. Many students like this format. If they miss a class, the videotape is available. Students less fluent with English can review the tapes of a class, and pace the lecture to match their comprehension.

But the on-line environment is different in many ways from the standard classroom situation [5], and the students who participate are also. They are more directed toward personal needs and goals, want courses to be relevant to their jobs and interests, and are less willing to enroll in courses dedicated to a professor's research agenda.

For a hands-on, team-based and project-oriented course, the distance-learning environment is a challenge. I have now taught this course twice on-grounds and once on television, and am preparing to do it again via distance learning. In this paper, I review my experiences in the previous distance - learning version of the class, and discuss plans for the next one.

First distance-learning offering

The 1999 offering of this class had 33 students at 8 sites in Virginia and Pennsylvania. Five students were alone at their sites. Charlottesville had 20 students, Hampton 5, and Northern Virginia 3. On campus we had a mix of undergraduates and graduate students; all off-grounds students were graduate students with full time jobs in industry.

In the Distance Learning situation, the first class must deal with logistics and expectations. This is a different kind of educational environment and is new to many of the students. The studio arrangement separates the students from the professor, and the fact that the class is videotaped intimidates some students. Our system is two-way audio and video; so interaction is possible. But, the professor must encourage the students to get them talking in this environment. The students focus their attention on the video monitors - even those physically present in the studio. Thus, the medium does control and constrain the interactions. Discussions can take place in real time between students at different sites, but only one such discussion can occur at any time.

All students in the class had a computer and access to the Internet. Materials were distributed through the class web page. Assignments were all submitted by e-mail. Students were expected to use computers in all stages of their projects - modeling and visualization, communications, data analysis, spreadsheets, word processing, and presentations.

Logistical issues included how to form teams and how large those teams should be. Prior to the start of the semester, I had made the decision to have at least one off-site member on every team. Further, I felt that each team should have 5 or 6 members. When we actually tried to compose the teams, these rules had to bend.

The Hampton site originally had 6 students (one eventually dropped); they wanted to work together and quickly established their project idea. The three students from Northern Virginia also agreed to work together, and they were grouped with two students from Charlottesville. In Team 3, two of the students had developed their project idea prior to the start of the class, and they found other students willing to work with them. I assigned one off-grounds student to their team. The final composition of the teams is shown in Table 1.

Table 1: Team composition

	On grounds	Off grounds
Team 1	0	5
Team 2	2	3
Team 3	3	1
Team 4	4	1
Team 5	4	1
Team 6	4	0
Team 7	3	2

The next logistical issue involved generating ideas, and compiling a list of possible topics. We did brainstorm during class, but many good ideas came in after class by e-mail. It is unclear whether the students were hesitant to speak up in class, or if they had the ideas after class was over. We distributed a list of over 70 possible projects for the teams to select from. I had originally planned to let teams form around topics – as we usually do in the on-grounds course. But that proved awkward, so the teams were assembled and allowed to select what they wanted to pursue. Titles of the projects completed in this class are listed in Table 2.

Table 2: Projects

Team 1 Adapt – An - Organizer for cabinets
Team 2 Space Saver 2000 Bike Rack
Team 3 Ambulatory Peritoneal Dialysis Device
Team 4 Quick Check Tire Pressure Sensors
Team 5 Teacher's Pet: a pet training device
Team 6 Item-Miser Dorm Room Organizer
Team 7 One Step Pressure Check

Team 6 started the semester with one idea and finished with another. They discovered that their original concept was already patented, and marketed through a major office supply company. Three teams developed ideas that were patentable, designed and built a reasonable prototype, and had a convincing business plan. The best teams had one or more champions for their project – members with a personal interest in the idea and enthusiasm for the product. One of these teams has pursued their project beyond the class. Two teams had reasonable ideas, but failed to achieve convincing business plans. Two other teams developed analytical approaches they were not able to realize as working prototypes.

Assessments. Because this was the initial offering of this course in this format, I tried to monitor the class dynamics closely. The reports from students included a first day survey (who are you and what do you expect to get out of this course?); midterm evaluations (how are things going?); a series of team ratings; and a last day survey (did you get

what you wanted from this class?). We also obtained the usual formal course evaluations.

The students reported generally high levels of satisfaction with the course and its content. They felt they got what they wanted from the class, and that we covered the material well. The only consistent complaints were from a few graduate students and most of the undergraduate students who don't like the distance-learning format. Off-grounds students expressed some dissatisfaction with the on-grounds students; they felt that the undergraduates weren't serious enough about their duties and deadlines, and that the graduate students were too concerned with theory and analysis, and not focused on practical issues.

Only one student never got into the spirit of the course. He wanted a lecture-and-assignments course, rather than an open-ended cooperative learning experience. He would disappear, and not respond to e-mail or complete assigned tasks. His team covered for him until the end of course, then they panned him in the final evaluations.

The students were far more satisfied with the course than I was. Of course, I have the context provided by the entire history of this class, and experience with other courses in the distance-learning mode. From my point of view there are three different courses: the standard on-grounds version, the first distance learning experiment, and the planned next on-line offering.

Conclusions

Virtual teams can be effective, but they require different strategies for success than collocated teams. Virtual teams need to plan better and coordinate their efforts. They must effectively divide their labor, and all members must come through. Classic project management techniques worked especially well in this class. Divide and conquer works very well when you don't have another choice.

Collocated teams can put in intense last minute efforts (the weekend before each critical deadline). They can also work with evolving prototypes, which are physically available to all team members. Some of our teams arranged regular face-to-face meetings, and the Northern Virginia members of one team came to Charlottesville for their final presentations.

What is class time for? Distance learning emphasizes the division between content and teaching style; the instructor feels there is so much to cover and wants to lecture. But the real benefit of this course comes when the instructor gets out of the way and lets the students work on their projects. The interaction of the team members is the crucial factor in the team's success.

The challenge is how to get key ideas and methods across without spending class time on lectures. The professor has to fight the tendency to lecture. In the on-grounds version of the class, that is easy. In the TV environment, it is more difficult. In previous TV courses, my mind set was to fill the

airtime with material. In this class, my students started requesting in-class time for on-air meetings. I finally got the message and let the students have the last part of every class. Each group could request time from a few minutes to a half hour for an on-line team meeting.

Is this the best environment for this type of class? Clearly not, collaboration is best done face-to-face. Were the results acceptable? Most students seemed satisfied with the course. The instructor had reservations, but will try again in this mode. Should this class be offered again in this format? Yes, this is exactly the kind of course engineers practicing in industry want. They are seeking practical courses focused on business issues. So the important question is "How can the delivery of this course be improved?"

Creativity and New Product Development will again be offered in distance-learning mode in the spring of 2002. I am currently restructuring the course, and preparing for a new delivery system. Lectures and demonstrations will be available asynchronously via streaming video on the Internet. Class will meet formally only one day each week, but students will be expected to have viewed the on-line lecture prior to each meeting. Class time will be reserved for team interaction and group activities. Additional facilities will be available for video-conferencing, so teams can arrange meetings outside the class period. The class web page will be enhanced and links provided to many relevant sites. Rather than lecturing, certain topics will be covered by having the students search for and summarize for the class material available on the World Wide Web.

We will publicize this class so as to encourage multiple students at each site. "If you enroll, bring a friend." Having another person physically present in the classroom will enhance the sense of being on a team. (One of our remote students chose to drive to Charlottesville rather than to a site closer to home to be with other students; in Tidewater, the students clustered at one location; instead of three sites.). We need to combine the distance-learning mode with local support and interaction.

There is an evolving theory and set of techniques for web-based collaboration [6,7], and lots of activity promoting engineering entrepreneurship. Several exciting new books are also available to motivate and inspire our students [8,9].

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