AC 2008-879: TEAMWORK AND THE CREATIVE PROCESS: PROMOTING CREATIVE THINKING THROUGH TEAMS

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Teamwork and the Creative Process: Promoting Creative Thinking Through Teams

Abstract

In today's complex and dynamic business environment, companies in every industry, including those in the manufacturing industry, cannot afford to become complacent in their operations, or the ways they provide products and services. As global competition and technological innovation continue to challenge the manufacturing industry, companies are being forced to become more creative in order to meet the needs of customers and compete on an international level. Therefore, as engineering and technology students assume leadership roles with their prospective employers, it is important for them to have an understanding of creative thinking and how to promote it with their employees.

Acknowledging the reality of the global economy and the need to develop creative thinking skills, some engineering and technology related programs are taking the initiative and integrating creative thinking into their curricula. Teaching creativity and encouraging innovative ideas can be done with individuals and teams. However, teamwork and team learning offer several advantages in comparison.

When using teams to initiate ideas, highly effective idea-generating teams don't just occur naturally. Certain team components need to be developed to facilitate the production of innovative ideas and solutions. A progressive approach used by the author for teaching creative thinking involves the use of the team concept and teamwork activities.

This paper will describe how the team concept can be used to promote creative thinking among students. The paper will focus on the importance of promoting creative thinking for engineering and technology students and how to use teams to teach students about creative thinking. The paper will help to prepare students for their future leadership roles by providing an understanding of creative thinking and how to promote it with their employees. Also, much of the discussion in the paper will have application for developing individual creative problem solving.

Introduction

To meet the global challenge, and the solve complex and dynamic problems confronting the manufacturing industry, leaders will have to rely on creative thinking and innovation[1]. The era of competitive complacency has been over for decades therefore, every organization must strive for continuous improvement in the ways goods and services are provided. Organizational survival requires that business leaders and employees develop creative thinking skills[2].

It is paramount for engineering and technology programs to develop curricula and courses that emphasize the development and use of creative thinking skills for problem solving and decision making. For several years, the author has been using a team oriented learning approach to teach OLS 350, "Creativity in Business and Industry," for students in the engineering technologies and

organizational leadership programs. As the paper will discuss later, the team concept can facilitate creative thinking and offer a number of advantages in creative problem solving.

Importance of Creativity in the Manufacturing Industry

The author's research in creative thinking and experience as a teacher and industry consultant/trainer has made him aware of the need for education on creative problem solving. Competition between manufacturing companies throughout the world is forcing business leaders and employees to become creative and innovative problem solvers. As technology and change continue to dominant the industry, it is essential for manufacturing leaders and employees to possess the creative thinking skills to find innovative ways to compete on a global scale[3].

Acknowledging the future leadership roles of engineering and technology students, the author's academic department has taken the initiative to emphasize creative problem solving and decision making. As future leaders, students will have a tremendous impact on upcoming events that will have global effects.

What is Creativity

The author's research on the various theories of creativity is discussed in OLS 350. For example, the split brain theory is one of the brain theory discussed in the course. According to that theory, the human brain is viewed as being divided into two hemispheres with each hemisphere being responsible for different types of thinking. The left hemisphere of the brain is primarily responsible for logical, linear, sequential, analytical and quantitative thinking while the right hemisphere is responsible for imaginative, intuitive, and holistic thinking. Although there are various definitions of creativity, one definition used by the author and in the book required for the course emphasizes that creativity is a 5 phase process where the problem solver uses both left and right brain thinking to solve problems and make decisions[4].

The Creative Problem Solving Process

The 5 major phases in the "creative problem solving process" are listed below[5].

Phase 1: Problem definition- The first step in creative problem solving requires that the problem be accurately defined and understood. The creative problem solver believes that every problem presents danger and opportunities. To deal with the first part of problem definition, the danger part, the problem solver needs to collect and analyze relevant information and data about the problem. During the information collection and analysis phase, the problem solver can identify the causes or reasons which created the situation and the negative consequences that will result if the problem is not properly solved.

The second part of problem definition involves identifying trends and opportunities associated with the problem. The creative problem solver needs to engage in holistic thinking and focus on the context of the problem to identify opportunities for positive change and innovation.

Phase 2: Idea Generation- Once the problem is accurately defined, the problem solver can engage in idea generation, where a "quantity" of ideas are brainstormed while deferring judgment about the practicality of those ideas. The ideas generated should include unusual and unorthodox ideas to facilitate the opportunities for innovation that are presented by the situation.

Phase 3: Idea Evaluation- Converting unusual and unorthodox ideas into practical ideas is the focus of the third phase of the creative process, idea evaluation. Throughout this phase the problem solver uses a combination of analytical and imaginative thinking to reduce the quantity of ideas generated during the idea generation phase into fewer quality ideas.

Phase 4: Idea Judgment- The fourth phase of the creative process focuses on identifying the best idea for solving the problem. To identify the best idea among several good ideas, the problem solver needs to establish criteria to evaluate or judge the remaining ideas from the idea evaluation phase.

Phase 5: Solution Implementation- The final phase of the creative process is where the best idea identified in phase four is implemented. During the solution implementation phase, the problem solver performs a variety of roles for implementing the idea including: directing, planning, organizing, and gaining support.

Teamwork and the Creative Process

Tables 1 and 2 identify the major advantages and limitations of creative problem solving teams over individual problem solving[6].

Table 1: Major advantages of creative problem solving teams

- More information and knowledge available to solve problems
- Generation of more ideas
- Synergistic effects of problem solving teams
- Different thinking skills available to solve problems
- Greater likelihood for finding the best solution
- Greater solution acceptance and commitment of the chosen solution

Table 2: Major limitations of creative problem solving teams

- Requires more time to solve problems
- Potential for conflict among team members
- Potential for groupthink

Using Teams to Teach Creative Thinking

The author uses the team concept to promote creative thinking among students in different ways. Table 3 provides guidelines for forming creative problem solving teams.

Table 3: Guidelines for forming creative problem solving teams

> - Become familiar with the benefits and limitations inherit in team problem solving
> - Each team should be composed with diverse members- genders, experiences/ages, thinking styles, etc.
> - Identify a time frame for completing the in-class assignment or project
> - Have the team identify a team advocate who will introduce the team members and present the teams ideas/solutions to the class
> - Set aside time to allow the rest of the class to discuss the team ideas presented
> - Evaluate the effectiveness of each team
> - With each assignment consider alternating the membership of each team

The author uses creative problem solving teams at different phases of the creative process and to solve specific organizational/industrial problems.

Using Creative Teams at Different Stages of the Creative Process

Using teams to teach creative thinking can be used at different stages of the creative problem solving process. Below, the author provides examples of how teams can be used with each stage of the creative process.

Problem Definition: Divide the class into creative problem solving teams and have each team define problems, either personal or work related, from a given set of facts.
Learning Outcomes:
- Understand problem definition
- Understand the importance of properly defining a problem

Idea Generation: Divide the class into creative problem solving teams and have each team create visual connections where a picture is used to describe observations about that picture. The team can use those observations to generate ideas for solving a given problem.
Learning Outcomes:
- Understand the benefits of visualization
- Understanding how to use visualization as a creative thinking tool

Idea Generation: Divide the class into creative problem solving teams and have each team identify mental barriers to creative thinking, such as the voice of judgment. The team can discuss situations where those barriers can inhibit risking taking, decision making and behavior.
Learning Outcomes:
- Awareness of the mental barriers to creativity
- Understand how mental barriers can inhibit creativity

Idea Evaluation: Divide the class into creative problem solving teams and have each team develop ideas into workable solutions.
Learning Outcomes:

- Recognize the importance of generating a quantity of ideas
- Understand how to develop ideas

Idea Judgment: Divide the class into creative problem solving teams and have each team evaluate different ideas using a judgment matrix in order to identify the best solution.
Learning Outcomes:
- Understand the importance of judgment criteria
- Understand how to use a judgment matrix

Solution Implementation: Divide the class into creative problem solving teams and have each team develop a plan of action for implementing a solution to a problem.
Learning Outcomes:
- Awareness of the need for a new round of problem solving
- Understand the importance of a plan of action

Using Creative Teams to Solve Organizational/Industrial Problems

Below, the author provides examples of how teams can be used to solve organizational/industrial problems.

1. Topic: Planning and scheduling
After reading a newspaper article on the poor performance of a given company, the class can be divided into creative problem solving teams to brainstorm and discuss how forecasting, capacity utilization and material requirements planning (MRP) can be used to improve operations and workload.

2. Topic: Just in Time (JIT)
After reading a newspaper article on global competition, the class can be divided into creative problems solving teams to brainstorm and discuss ideas on how implementing "just in time" (JIT) can reduce waste and meet the competitive challenge.

3. Topic: Plant layout
After reading a newspaper article on the industry consolidation of manufacturing companies, the class can be divided into creative problem solving teams to brainstorm and discuss ideas on how efficient plant layout can be used to reduce costs.

4. Topic: Methods and motion studies
After reading a newspaper article on U.S. companies investing overseas, the class can be divided into creative problem solving teams to brainstorm and discuss ideas about the different production costs that exist between U.S. and other countries. The teams can be used to develop ideas for promoting efficiency.

5. Topic: Statistical techniques
After reading a newspaper article on manufacturing unemployment, the class can be divided into creative problem solving teams to brainstorm and discuss the causes of the unemployment. Using statistical methods to review the unemployment statistics, the teams can be used to

develop ideas for reducing manufacturing unemployment.

6. Topic: Measuring performance
After reading a newspaper article on the declining U.S. productivity, the class can be divided into creative problems solving teams to brainstorm and discuss ideas on how to accurately measure employee performance and improve organizational productivity.

7. Topic: Continuous Improvement
After reading a newspaper article on offshore outsourcing, the class can be divided into creative problems solving teams to brainstorm and discuss ideas on how organizations can reduce waste and improve the efficiency of the factors of production in order to limit outsourcing.

Case Study

Each semester in OLS 350, student teams are used in problem solving case studies. The author's approach to teaching creativity involves problem solving on diverse topics of concern. The case study assignment requires each team (with the consent of the instructor) to identify a current problem, solve that problem using the 5 phases of the creative problem solving process and provide a ten minute presentation. Incidentally, the problem solving case studies are one assessment tool the author uses to evaluate the course because they involve contemporary, relevant, and real-life problems.

An example of the typical problem solving case study is taken from the Fall 2007 semester in OLS 350. The author randomly divided the class of 18 students into 4 teams composed of between 4-5 students. Table 4 lists the titles of the problems selected by each team.

Table 4: Problems identified by each team in OLS 350 (Fall 2007)

Team 1 (5 members): How to Deal with Workplace Bullies
Team 2 (4 members): How to Improve Student Retention at Purdue University Calumet
Team 3 (5 members): How to Improve Parking Concerns for Students with Disabilities at Purdue University Calumet
Team 4 (4 members): How to Improve Teachers at Purdue University Calumet

The author will discuss Team 3's problem solving case study, "How to Improve Parking Concerns for Students with Disabilities at Purdue University Calumet."

1. Facts Surrounding the Problem

Historically, Purdue University Calumet, along with many other universities, has had a parking shortage for students attending the University. Three years ago, the parking situation was improved when the university built a parking garage on the east side of the campus. However, there still remained a parking problem for students with disabilities. The designated (reserved) parking spaces closest to classroom buildings on the west side of the campus were often filled, leaving many students with disabilities having to park far away from their classes.

2. The Creative Problem Solving Process

Phase 1: Problem Definition- In what ways might the parking concerns of students with disabilities be addressed?

Phase 2: Idea Generation- Some of the ideas brainstormed for solving the problem:
    (1) Ask the university to provide more reserved parking spaces
    (2) Penalize violators of the existing parking rules
    (3) Enforce the rules on existing parking spaces
    (4) Provide more reserved spaces in the parking garage
    (5) Provide shuttle service from remote campus parking areas
    (6) Provide valet service for disabled students parking in remote areas
    (7) Provide reserved parking spaces by advance appointment
    (8) Provide temporary, 3-wheel scooters for disabled students
    (9) Establish priority reserve (stickers) parking among existing reserved parking
    (10) Allow student parking along the streets surrounding the university
    (11) Allow students with disabilities to park in the faculty and staff parking areas
    (12) Prohibit faculty and staff with disabilities from parking in the parking areas reserved for disabled parking

Phase 3: Idea Evaluation- The team refined ideas and discussed combining several ideas or components of the ideas generated in phase 2:

Combine Ideas (1), (2) and (3): Ask for more reserved parking
Combine Ideas (2) and (3): Stricter enforcement of parking rules
Combine Ideas (2), (3) and (4): Stricter enforcement of parking rules
Combine Ideas (2), (3) and (7): Establish parking by appointment
Combine Ideas (11) and (12): Limit faculty/staff parking in spaces for disabled persons
Combine Ideas (1) and (11): Allow students with disabilities to park in faculty/staff spaces at certain times
Combine Ideas (4) and (5): Provide shuttle service for students with disabilities
Combine Ideas (3) and (9): Establish priority reserve parking

Ideas resulting from Phase 3:

- Ask for more reserved parking
- Stricter enforcement of parking rules
- Establish parking by appointment
- Limit faculty/staff parking in spaces for disabled persons
- Allow students with disabilities to park in faculty/staff spaces at certain times
- Provide shuttle service for students with disabilities
- Establish priority reserve parking

Phase 4: Idea Judgment- To identify the best idea for solving the problem, the team established criteria and a "judgment matrix" to evaluate or judge the remaining ideas from Phase 3. Judgment Criteria:

- Cost in implementing the idea
- Time spent in implementing the idea
- The difficulty involved in implementing the idea
- The ineffectiveness of the idea

Table 5: Judgment Matrix (Team 3)

Rating Scale: 1 (low) – 5 (high)						
Ideas	Cost	Time	Difficulty	Ineffective	Total	Rank
More reserved parking	5	3	5	1	14	2
Enforce parking rules	5	5	5	1	16	3
Parking by appointment	5	5	5	1	16	3
Limit faculty/staff parking	5	3	5	1	14	2
Parking in faculty/staff spaces	5	5	5	1	16	3
Provide shuttle service	5	3	5	1	14	2
Priority reserve parking	3	3	2	1	9	1

Solution: Establish priority reserve parking for students with disabilities.

Phase 5: Solution Implementation

Step 1: Identify the number of parking spaces required for students with disabilities
Step 2: Contact the Chancellor and Student Support Services to establish support for the idea
Step 3: Communicate the priority reserve parking system to the faculty, staff and students
Step 4: Continue to enforce existing parking restrictions
Step 5: Evaluate the solution in 6 month using campus-wide surveys

Table 6 lists some of the questions used to assess the behavior of individual team members[7.]

Table 6: Selected questions used to provide feedback to the team members and instructor on the usual behavior of individual team members

Rating Scale: 1 (Strongly Disagree) - 5 (Strongly Agree)
- This team member frequently initiates ideas - This team member is directed toward team goals - This team member manages conflict - This team member demonstrates support for others - This team member displays openness - This team member exhibits proper demeanor in decision making

Average score from members of Team 3 concerning peer feedback: 4.6

Table 7 lists some of the questions used to assess the team and team assignment[7].

Table 7: Selected questions used to provide feedback to the team members and the instructor on the team and team assignment

Rating Scale: 1 (Strongly Disagree) - 5 (Strongly Agree)

- This was an effective team
- I clearly understood the team goals for this assignment
- The team stayed on track in working toward its goals
- The team considered my contributions
- I felt free to express my opinions and make a contribution to the team
- Conversion was balanced among members
- I was satisfied with this team assignment

Average score from members of Team 3 on team assessment: 4.6

Course Assessment

Continuous improvement is the nomenclature used in academia and industry for the process of evaluation and improvement. Each semester, several assessment tools are used to evaluate the relevance and effectiveness of OLS 350, including team problem solving and relevant assignments. Listed below are some of the assessment tools the instructor frequently uses to evaluate OLS 350.

1. Course Evaluations

The instructor evaluates the effectiveness of the creative thinking education provided in OLS 350 by using student evaluations which consist of between 16-20 questions about the course. Table 8 lists the average ratings from student evaluations for 2004- 2005 and Table 9 lists selected questions asked on student evaluations.

Table 8: Average rating from student evaluations for OLS 350 (2004-2007)

Rating Scale: (5) Strongly Agree, (4) Agree, (3) Undecided, (2) Disagree, (1) Strongly Disagree

Year:	2004	2004	2005	2005	2006	2006	2007	2007
Semester:	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Students:	25	20	14	17	16	22	23	18
Avg. Rating:	4.81	4.74	4.91	4.71	4.78	4.70	4.76	4.79

Table 9: Selected questions asked on student evaluations for OLS 350

No.	Question
4	Assignments are clearly explained
38	Conceptual understanding is emphasized
68	I feel free to express & explain my views in class
70	I feel free to ask questions in class
81	The course has clearly stated objectives
88	Lecture information is highly relevant to the course objectives
92	I can apply the information/skills learned in this course
117	Exams stress important points of the lecture/text/assignments
C03	Assignments are relevant, interesting and well-integrated
C04	The course has stimulated my thinking
C07	Overall, I feel I have learned a great deal in this course

2. Pre and Post Test

To evaluate the effectiveness and degree of learning that occurred in OLS 350, the author administered a pretest at the beginning of the semester and a posttest at the end of the semester. The questions asked on both test were the same and reflect a sample of the various creative thinking issues, including team problem solving, covered in the course. Table 10 list the results from last semester's pretest and posttest and Table 11 list selected questions asked on the pretest and posttest. Incidentally, the results from last semester's pretest and posttest are consistent with those of previous semesters

Table 10: Results from the pretest and posttest for OLS 350 (Fall 2007)

Pretest:	Posttest:
Number of students: 20	Number of students: 17
Average Percent of Correct Answers: 58.7%	Average Percent of Correct Answers: 81.5%

Table 11: Selected questions asked on the pretest and posttest for OLS 350

True/False Questions
1. Groupthink has a positive effect on team problem solving
2. Humor and play should be avoided when teams are generating ideas
3. For every problem there is one right answer for that problem
4. Creative teams believe that "if it's not broke-don't fix it."
5. Creative teams believe that every problem has an opportunity
6. It is easier to develop a wild idea than to invigorate a weak one
7. "Creativity" is a personal characteristic that only certain people possess
8. Analysis is to break apart and synthesis is to put together
9. Team problem solving generally results in greater solution acceptance/commitment
10. Synergy can be positive or negative

Conclusion

The competitive situation confronting the manufacturing industry is much different from that of twenty five years ago. Globalization and technological innovation have influenced the way organizations provide services and manufacture products. In today's competitive economy, companies in the manufacturing industry cannot afford to become complacent about their products, manufacturing processes, market positions or skill development. Creative thinking is the type of education engineering and technology students need to facilitate their careers and meet the competitive challenges confronting their prospective employers.

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