Creative Thinking: The Generation of New and Occasionally Useful Ideas

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ABSTRACT

Most of us admire the trait of creativity and many of us wish that we had more of this somewhat intangible trait. We encourage our students to be creative or tell them that they are not being creative enough, but how many of us actually foster the growth of creativity? Engineering and technology students often do not think of themselves as creative even though their occupations will require them to use a wide variety of problem solving skills in many different situations. If we accept that being creative is the means to produce and express new, novel and occasionally useful ideas then we should be able to apply this to our students. A creative thinker should be better equipped to find and define problems and implement the resulting solutions. There are almost as many theories about creative thinking as there are authors writing about the subject. This paper will examine some of the theories about creative thinking, the process, and some of the aspects of teaching and learning creativity.

Creative Thinking Theories

Much research has been done on the topic of creativity, creative nature and ability, and creativity and the design process (Klukken, et al., 1997, p.134). As we look at creativity from the perspective of student development and engineering and technology students, it is helpful to first address the definition of creativity. Dowd (1989) concludes that creativity involves the art of making or producing something, specifically something that is new to the user. He maintains that without the actual production of something, there is no creativity, and that thoughts, in and of themselves, are not creative. Goetz (1989) states that "Creativity has a connotation of originality, which may be characterized by novelty, difference, ingeniousness, unexpectedness, or inventiveness" (p.412).

There are a variety of theories about creative thinking and creative behavior. Among the most popular are the Right Brain- Left Brain theory discussed and advocated by many including Edwards (1986) and Oldach (1997) and the Hermann (1989) four-quadrant model of thinking preferences. Although studies have yet to prove any one theory of creativity, the commonality of most theories is the sense of process.

We often describe creativity as if it were a thing, yet, creativity does not happen without a problem, a process, and a solution. Sommese & Sommese (1997) compare being creative to making soup because it takes time and lots of ingredients. Odalch (1997) describes it as a process that requires commitment, practice, and time. Creative thinking has often been described as divergent thinking, or looking at problems from a different point of view than ordinarily used. Many of us have been urged to think outside of the box. deBono (1992), who has pioneered lateral thinking techniques writes that the search for new ideas often requires a shift in the thought process to apply a preconceived idea or information to a new problem.

These definitions all have relevance to the engineering or technology classroom, where, hopefully, the students are learning to come up with new ways (novelty, inventiveness) to solve design problems (product). This focus on problem solving is a reflection of the learning institutions' desire to adequately prepare students for the creative demands that industry will place on them after graduation from their respective courses of study. As a recent article states, "In the competitive marketplace, [creativity is] a crucial asset in the bid to win the race to build better machines, decrease product delivery times, and anticipate the needs of future generations" (Gibney, 1998, p. 20). Creativity is a talent that industry as a whole requires and desires from its employees, and is especially applicable in the realm of design and technical graphics. The importance that companies are placing in this area can best be summarized by this statement by the American Management Association:

> Organizations are seeking to apply creativity to problems and opportunities. They need to invent new ways of developing, producing, and distributing goods, services, and information. And they need employees who can help them move forward. As a result, the competencies and behaviors that are now becoming essential to competitiveness and effectiveness center on the creative process: Individuals who want to be successful must learn how to break with tradition, how to develop ideas and, eventually, how to do things in a new way. (Prather & Gundry, 1995).

It is apparent that for technology and engineering students to succeed in their future employment, they will most likely need to have a significant amount of creative ability.

The Creative Thinking Process

Generally, a description of the creative thinking process contains several steps. These might include:

1. ***Definition of the problem***
   Without a problem there is generally no need to be creative. The types of problems are as diverse as the people who are solving them. Artists create works of art which solve problems related to space, color, dimension, design, and emotion. Performers solve problems related to sound, music, emotion, and performance. Engineers and technologists bring mathematics and science to bear on practical problems, molding natural materials and harnessing technology for human benefit (Gibney, 1997).

2. ***Research or collection of data***
   It is virtually impossible to solve a problem, or to devise a creative solution to a problem unless we know as many aspects of the problem as possible. To solve engineering or technology problems we must be well founded in math and science. Creativity often goes hand-in-hand with knowledge, and there has been much discussion about the relationship between intelligence and creativity. While no clear connection has been proved, in fact, in some studies it has been disproved, there is evidence which show that high intelligence allows individuals to master a wide variety of material which gives them many options when attempting to solve a problem (O'Neil et al., 1994). People with less mastery of supporting material often have a tendency to apply known solutions to new problems.

3. ***Incubation***
   This stage is often ignored by those who are in a hurry to come up with a solution. During the incubation stage the creative person has already defined the problem and collected the necessary data to understand the problem and some of the ramifications for solving it. At this time the creative person is able to set the problem aside and work on

something else, while at the same time reminding themselves occasionally that the problem still needs to be solved. In order to promote an atmosphere conducive to our own creative thoughts, we must consider how we individually work the best. To maximize our creative thinking you should ask yourself the following questions.

a. What is your best time of day?
Are you a morning person? If so try set aside time in the mornings to concentrate on creative activity. If you are a night person then plan your time accordingly.

b. Where do you do your best thinking?
Amazingly, the answer to this for many people is in the shower. Perhaps it is the enclosure of the small space, the comfort of the water, or the daily routine. It doesn't matter why, if you often get good ideas during the shower, then remember this and try to capitalize on it. Put a note outside the shower stall with reminders of problems you are trying to solve. Others think best while driving to work, brushing their teeth, falling asleep. If you wake up at night with good ideas, keep a pad by your bed so you will be able to remember the ideas. Many people get their best ideas while they are exercising. Once the body is working hard, the mind seems to get bored and often stretches out into new territories.

c. What can you do to be more creative when nothing seems to be working?
Try something different. Take a walk, stretch, get a drink of water. Often physical activity or a change in environment can trigger a response or solution that would not have come if we had stayed seated at our computer.

4. Insight or illumination
This is often described as the 'Aha' experience, when the answer or solution appears as if out of nowhere. This is the stage often least understood by someone outside the creative process. To the outsider, the solutions just seems to appear to the creative person with no work, forethought, or concentration, when actually just the opposite is true. By giving the problem time to simmer in the background and combining it with the knowledge gained in the research phase, the creative person mentally goes through and rejects a whole variety of possibilities before the final solution.

5. Evaluation, verification, or elaboration
This stage is important because we must examine, test, and possibly revise our solutions to make them workable. At this point the new solution must be examined to see if it solves the initial problem that was presented and determine if it is viable.

Although these steps are not standard, the resemblance from one researcher to another is remarkable. The process is not always the same, but it is accepted that creative processes are those that generate original and adaptive ideas, solutions and insights.

Teaching Creative Thinking
If creativity is the process which generates new ideas and solutions, the question than becomes, "Can creativity be developed or enhanced?" If so, how is it generated, and what helps or hinders this process in the classroom? Researchers have spent many years analyzing the nature of creativity and what determinants exist that cause some to exhibit more innate creative ability than others. Results of many studies indicate that creativity is a developed skill that anyone can acquire, regardless of what is generally referred to as one's natural creative ability. Harrisberger (1982) states, "Creativity is now regarded as a mental ability that may be improved by training" (p. 52). Another expert in this field says, "If the influence of genetic factors on the development of cre-

ativity is of minor or no importance, it should be possible to teach or train many aspects of creative thinking in much the same ways as educating to read and to do arithmetic" (Vernon, 1989, p.105).

Accepting these and other results to be valid, educators then find it necessary to examine the characteristics of the classroom that assist in creative development, as well as the type of assignments that are most likely to foster creativity. Invariably, creativity researchers point out two factors that have significant impact on the creative process in any task: personal interest in the problem, and the absence or presence of external constraints. Amabile and Tighe (Amabile & Tighe, 1993) (Amabile, 1983) state that individuals will most likely take the more exploratory route when they are interested in the problem area, and when their environment does not present excessively limiting demands. These experts also state that anything that leads a problem-solver to get deeply involved in focusing on or thinking about a task will enhance creative ability. Additional research clarifies that constraints consistently hinder creativity and decrease task motivation.

When Lanny and Kristen Sommese professors of design at Penn State and partners in Sommese Design were asked how they taught creativity they were both at a loss for an answer. After some examination, they decided that they didn't teach creativity directly, but rather incorporated it into every project, process, and paper they assigned their students (Sommese & Sommese, 1997). Since sometimes just the mention of being creative is intimidating they choose to integrate the creative process into existing projects rather than do exercises which are designed to develop creative (Oldach, 1997).

The relationship between creativity and intelligence remains debatable. In a review of the research investigating the relationship between intelligence, creativity, and academic performance, McCabe (1991) found varied results. In a study which was concerned with the influence of intelligence and creativity on academic achievement of females in three subject areas, McCabe's results suggested that high levels of creativity may be associated with high levels of academic performance, however, it may be just that the skills taught and assessed may be largely acquired by those with high levels of intelligence rather than high levels of creativity. Feldhusan (1995) studied the lives of twenty creatively productive people including Lewis Sullivan, Thomas Jefferson, and Frank Lloyd Wright and concluded that the following signs were apparent in their lives.

1. Early mastery of knowledge and/ortechniques in a field or art form
2. Signs of high-level intelligence, reason ing ability, or memory in early childhood.
3. High energy level, drive to produce, commitment or devotion to study or work as a young person.
4. Intense, independence, preference for working alone, individualism.
5. A sense (self-concept) of creative powers and in internal locus of control.
6. Heightened sensitivity to details, patterns, and/or other phenomena in the world.

Feldhusan went on to conclude that the creative thinkers have a well developed knowledge base and a set of strategies for processing new information. They have a mastery of skills within their own area, and they have acquired a set of attitudes or dispositions that allow them to search for new configurations or unique solutions.

Courses and Approaches

Industry has begun to look at the role creativity can take within their organizations. Between 1986 and 1990 the number of organizations that offer creativity training doubled from 16% to 32% (Hequet, 1992). DuPont and Frito-Lay are among the organizations with a focus on creative problem solving. At Frito-Lay, creativity training saved more than $500 million in the 5-year period from 1983 to 1987, while profits grew at a rate of 12% annually (Hequet, 1992).

In her article on Awakening Creativity, Gibney (1997) describes four courses in engineering programs at major universities where creative thinking is the focus. Stanford University, Purdue University, Rensselear Polytechnic Institute, and Kettering University all offer courses to engineering students which use a variety of techniques to foster the growth of creative approaches. According to Swersy at Rensselear, engineers who have not been encouraged to be creative tend to fall back on obvious solutions, instead of developing something novel. Although the methods are different, each of these courses focuses on the relationship between creativity and the engineering process and opening the students' minds to their own creative potential.

Within a course that has other objectives as its major goals, it is important, however, for us to realize that creativity can be introduced, fostered, taught, and learned . While most of us do not have the time or the luxury to devote an entire course to the development of creativity skills in our students, we can incorporate some of these techniques into our classes. By necessity, most engineering and technology classes focus on facts, details, memory and predetermined answers. This general and specific knowledge creates a good base for the creative thinker if we as educators offer open ended activities which promote the use of divergent thinking rather than the one right answer approach.

Conclusion

While there is no clear cut definition of creativity or the creative process, it is likely that most students can develop creative skills if curriculum content and environment contain the necessary ingredients. These ingredients include assignments that require the students to explore novel approaches or applications, tasks that interest and motivate the students, and problem sets that are not unnecessarily constrained in problem solving method or result. The challenge for the educator is to provide an environment that enhances creativity development. Ideally, we would be able to offer entire courses in our curriculum devoted to creative thinking methods, theories and techniques. Since this is not possible, we must endeavor to provide opportunities for our students to experience the creative process and develop their own techniques and skills for future use.

References

Amabile, T. M. & Tighe, E. (1993). Questions of creativity, *Creativity,* 7-27. New York: John Brockman Associates, Inc.

Amabile, T. M. (1983). *The social psychology of creativity*. New York: Springer-Verlag

deBono, E. (1992). *Lateral thinking*. New York:Harper & Row.

Dowd, E. T. (1989). The self and creativity. *Handbook of creativity,* 233-242. New York: Plenum Publishing Corp.

Edwards, B. (1986). Drawing on the artist within. New York: Simon and Schuster, Inc.

Feldhusan, J. F. (1995). Creativity: A knowledge base, metacognitive skills, and personality factors. *Journal of Creative Behavior*, 29 (4), 255-268.

Gibney, K. (1998, March). Awakening creativity. *ASEE Prism, American Society for Engineering Education*. Washington, D.C., 19-23.

Goetz, E.M. (1989). The teaching of creativity to preschool children. *Handbook of Creativity*, 411-428. New York: Plenum Publishing Corp.

Harrisberger, L. (1982). *Engineersmanship-: The doing of engineering design*, (2nd Edition). Belmont, CA: Wadsworth Inc.

Herrmann, N. (1989). *The creative brain.* Lake Lura, North Carolina: Brain Books.

Hequet, M. (1992). Creativity training gets creative. *Training*, 2, 41-46.

Klukken, P.G., Parsons, J.R., & Columbus, P.J. (1997). The creative experience in engineering practice: Implications for engineering education. *Journal of Engineering Education*, 86 (2), 133-138.

McCabe, M. P. (1991). Influence of creativity and intelligence on academic performance. *The Journal of Creative Behavior*, 25 (2), 116-122.

Oldach, M. (December, 1997). Getting your brain ready for creativity. *HOW*, 150-154.

O'Neil Jr., H. O. , Abedi, J. & Spielberger, C. D. (1994). The measurement and teaching of creativity. In H. F. O'Neil Jr. (Ed.) & M. Drillings (Ed.), *Motivation: Theory and Research*, 245-263. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Prather, C.W., & Gundry, L.K. (1995). *Blueprints for innovation: How creative processes can make you and your organization more competitive.* New York: American Management Association.

Sommese L. & Sommese K. (1997). Learning how to be creative. *Dynamic Graphics*, 32-39.

Vernon, P.E. (1989). The nature-nurture problem in creativity. *Handbook of Creativity*, 93-110. New York: Plenum Publishing Corp.