Session 1664

An Experiment in Process Education^{TM} Applied to Physical Metallurgy

Dale A. Wilson, James Corbeil
Tennessee Technological University

Abstract

Difficulties in the learning process, which have occurred during previous physical metallurgy lectures, lead to the incorporation of a new teaching philosophy. In an attempt to alleviate these difficulties, various methods were considered, such as Process Education^{TM}. Process Education^{TM} encompasses the philosophy that learning, thinking, problem solving, communicating, assessing, and teamwork are processes to be developed and continually improved by students as they construct knowledge. Process Education^{TM} incorporates cooperative learning, guided discovery activities, journal writing, and various assessment tools.

Unlike a lecture based approach, a Process Education^{TM} class requires more active participation of both mentor and team members. Team members actively work through in-class tasks, which include critical thinking, assessment, deadlines, and journal entries. With this approach the instructor take on the nontraditional role of facilitator. This approach has shown significant improvement in both student motivation and their retention of knowledge.

Introduction

The education of engineers has been a topic of concern and discussion for many years and will be so into the foreseeable future. With the current trend in industry heading toward the formation of efficient design teams, overwhelming concerns that graduates do not have the skills necessary to compete in this environment have arisen. It is becoming clear that change is in order if the educational system wishes to continue to turn out quality engineers. This paper demonstrates how the use of an innovative educational process, like Process Education^{TM}, can be effectively applied in the class room environment and produce continued excellence.

What is Process Education^{TM}?

The term 'process' is defined as a sequence of activities, which over a finite period combine to produce a change. The main objective of Process Education^{TM} is to develop "self-growers" using innovative concepts, processes, and tools. The outcome of this process is the creation of environments which are instructive, enlightening, and assist students with self-assessment skills. In order to create an atmosphere conducive to learning, an educator must develop students' learning skills using cognitive, social, affective, and psychomotor methods; improve students' self-assessment skills; and improve the processes associated with education: teaching, learning, curriculum design, assessment, mentoring, retention, and educational administration.

In Process Education™, the educator assumes the role of mentor to aid in the growth and development of learners using a student-centered approach to teaching. The design, implementation, and quality of curricula are important if the mentor hopes to shift the control and ownership of the learning process to the learner and hence develop "self-growers". Some of the teaching techniques include: problem-based learning, guided-discovery learning, applied critical thinking, structured self-reflective thought, journal writing, project work, and cooperative learning.

The development of a cooperative learning environment is one of the aforementioned techniques that Process Education™ has adopted to facilitate learning. Performing as groups helps to foster skills associated with communication, teamwork, and assessment. Within each team, students assume roles, which include captain, recorder, reflector, and spokesperson. Each member has a specific job that aids the team in accomplishing tasks, and in addition to their assigned roles, each member offers their peers additional assessment and tutoring. [1]

Course Description

The Physical Metallurgy course, used in this experiment, is an introductory materials course taught to Industrial Technology students. The objective of this course is to develop an understanding of the basic principles of materials and physical metallurgy and their applications.

After previously teaching the course there was a concern about the motivational and performance levels of the students. This class is a service course for Industrial Technology taught by the Mechanical Engineering Department, and the students perceive it as not being a core class in their program of study, i.e. not as important.

The Experiment

In addition, the educational system has in the past been biased toward teaching certain psychological types as defined by the Myers-Briggs Type Indicator test. Traditionally, the typical engineer or scientist type is introverted, sensing, thinking, and judging (ISTJ) type; therefore, courses are constructed to facilitate and appease these sensing types (see Table 1 for description of personality types).

To meet today's growing demands for quality professionals, there needs to be an ability to function in high performance interdisciplinary teams. The characteristics needed for the "new" professional are typically not developed in the standard lecture-style class. More emphasis must be placed upon interpersonal skills, relational, and intuitive approaches to problem solving. This is the goal with new educational processes, such as Process Education™.

The incorporation of cooperative learning elements, such as teams, has been shown to improve the overall performance of students [2]. It has been demonstrated that as little as 45 minutes during a semester invested in team building can significantly improve team outcomes. The process of selection needs to be considered to maximize this performance. Diversity is

Table 1. Understanding Myers-Briggs Type as related to work situation [3]

Extroverts	**I**ntroverts
Like variety and action. Tend to be faster. Are often good at greeting people. Are often impatient with long slow jobs. Are interested in the results of their job, in getting it done, and in how other people do it. Often do not mind the interruption of answering the telephone. Often act quickly, sometimes without thinking. Like to have people around. Usually communicate freely.	Like quiet for concentration. Tend to be careful with details, dislike sweeping statements. Have trouble remembering names and faces. Tend not to mind working on one project for a long time without interruption. Are interested in the idea behind their job. Dislike telephone intrusions and interruptions. Like to think a lot before they act, sometimes without acting. Work contentedly alone. Have some problems communicating.
Sensing	I**n**tuitive
Dislike new problems unless there are standard ways to solve them. Like an established way of doing things. Enjoy using skills already learned more than learning new ones. Work more steadily, with realistic idea of how long it will take. Usually reach a conclusion step by step. Are patient with routine details. Are impatient when the details get complicated. Are not often inspired, and rarely trust the inspiration when they are. Seldom make errors of fact. Tend to be good at precise work.	Like solving new problems. Dislike doing the same thing repeatedly. Enjoy learning a new skill more than using it. Work in burst of energy powered by enthusiasm, with slack periods in between. Reach a conclusion quickly. Are impatient with routine details. Are patient with complicated situations. Follow their inspirations, good or bad. Frequently make errors of fact. Dislike taking time for precision.
Thinking	**F**eeling
Do not show emotion readily and are often uncomfortable dealing with people's feelings. May hurt people's feelings without knowing it. Like analysis and putting things into logical order. Can get along without harmony. Tend to decide impersonally, sometimes paying insufficient attention to people's wishes. Need to be treated fairly. Are able to reprimand people or fire them when necessary. Are more analytically oriented-respond more easily to people's thoughts. Tend to be firm minded.	Tend to be very aware of other people and their feelings. Enjoy pleasing people, even in unimportant things. Like harmony. Often let decisions be influenced by their own or other people's likes and wishes. Need occasional praise. Dislike telling people unpleasant things. Are more people-oriented-respond more easily to people's values. Tend to be sympathetic.
Judging	**P**erceptive
Work best when they can plan their work and follow the plan. Like to get things settled and finished. May decide things to quickly. May dislike to interrupt the project they are on for a more urgent one. May not notice new things that need to be done. Want only the essentials needed to begin their work. Tend to be satisfied once they reach a judgment on a thing, situation, or person.	Adapt well to changing situations. Don't mind leaving things open for alterations. May have trouble making decisions. May start too many projects and have difficulties finishing. May postpone unpleasant jobs. Want to know all about a new job. Tend to be curious and welcome new light on a thing, situation, or person.

important in the development of the teams. This can be accomplished by considering the students' majors, psychological types, races, genders, and grade point averages. For this experiment the class had only industrial technology students, therefore their major was not a factor. After each student had the opportunity to experience each role as a captain, recorder, reflector, and spokesperson, the team decided which member would perform in each role.

The first class assignment was to keep a daily journal for materials application from outside literature sources. Each class period had a time devoted in which each team would decide on their best journal entry and report it to the class for discussion. Similarly, for the assigned homework on the text material the teams would present their solutions or answers. That would be followed by another team assessing their results. The assessment, when possible, would include strengths, improvements, and insights. This requires the students to have their homework completed to support the team and to receive immediate feedback on the homework assignments and has the added benefit of decreasing the time spent in grading papers by the faculty member.

Periodically it is important for the students to assess if there is material they don't understand. Having each team develop two questions that they have over the current text material can do this. Also, hands-on activities are used to retain the major concepts. It quickly becomes obvious, while facilitating these activities that self-growth with active learners is far greater than in the passive lecture style and that higher level thinking can be developed. This format, therefore, results in only a few mini-lectures instead of the previous hour-long lectures.

The outcome of the experiment with this process was significant. Not only were the grades significantly better (as shown in Table 2), but the most important factor seems to be that the students who might have been disengaged had to be engaged in the activities in order to support their team and therefore a higher level of thinking is required of the students.

Table 2. Comparison of grades (97 vs. 98)

Year	# of student	A	B	C	D	F	X*	Avg. GPA
1997	27	1	11	8	4	2	1	2.11
1998	24	3	8	10	3	0	0	2.46
* Indicates final exam never taken.								

Conclusion

Understandably, this is a small experiment with a limited number of students, but the authors believe that this process has significant potential to improve the quality of the "new" engineer that is required by today's industry and assist in developing life-long self-growers.

Bibliography

1. Apple, Daniel K., and Krumsieg, Karl, *Process Education Teaching Institute Handbook*, Pacific Crest Software, Inc., 1998.
2. Miller, Christine, Subbiah, Karthikeyan, Wilson, Dale, "Evaluation of the Effectiveness of Design Team-Building: A 45-minute Investment Pays Off", 1998 ASEE Annual Conference Proceedings, June 1998.
3. Myers, Isabel B., *Introduction to Type*, 3rd edition, Consulting Psychologist Press, Palo Alto, California, 1970.

DALE A. WILSON
Dr. Dale A. Wilson is a Professor of Mechanical Engineering at Tennessee Technological University. He received his B.S. (1974), M.S. (1975) and Ph.D. (1978) from the University of Missouri-Columbia. Prior to joining Tennessee Technological University he spent 6 years in Mechanics of Materials and Structures at Pratt & Whitney Aircraft Group. He is a member of ASEE, ASME, ASTM, ASM International and Sigma Xi. He teaches Machine Design, Physical Metallurgy, and Mechanical Behavior of Materials and does research in related areas.

JAMES CORBEIL
James Corbeil is a candidate for a Doctoral Degree in Engineering at Tennessee Technological University. He received his B.S. (1996), M.S. (1998) from Tennessee Technological University. He is a member of Pi Tau Sigma. Currently, he is involved in studying the dynamics of design team interactions.