ACTIVE AND EXPERIENTIAL LEARNING

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Abstract

Active learning activities in a classroom engage students in the learning process. In active learning, students learn basic engineering design and analysis concepts through individual or team activities. These activities must be designed by faculty, so that they can bring their industrial experience into the classroom and create opportunities for students to think, apply concepts and to solve real-world problems. This definition may include traditional activities such as homework, but in practice active learning refers to individual or group classroom activities that enhance student engagement in the learning process. The active learning strategies that were used in sophomore & junior level engineering course are listed and discussed. The author lists his motivation for using active learning in sophomore & junior level engineering courses: reduce the number of students dropping the course, increase participation by students in learning the basic concepts, improve performance of students in tests, and develop an appreciation for mathematical models before the models are applied to solve complex problems.

Introduction to UW-Platteville

The University of Wisconsin-Platteville (UW-Platteville) is one of thirteen publicly supported comprehensive universities in the UW System. The University of Wisconsin-Platteville campus is located on the western edge of the city of Platteville in southwestern Wisconsin. The Greater Platteville area has a population of about 25,000 people. The university traces its origins to the Platteville Normal School, which was established in 1866, and the Wisconsin School of Mines, which was established in 1907. Today, the university is a multi-purpose, coeducational institution with an on-campus enrollment of about 7,500 students and another 3,000 students in distance learning programs. The university offers about 45 majors and about 75 minors in 50 academic fields, and is organized into three colleges: College of Business, Industry, Life Science, and Agriculture; College of Liberal Arts and Education; and College of Engineering, Mathematics and Science.

The College of Engineering, Mathematics, and Science consists of eight departments: Chemistry, Engineering Physics, Mathematics, Civil and Environmental Engineering, Electrical Engineering, Computer Science and Software Engineering, General Engineering, and Mechanical and Industrial Engineering. The College has over 2000 student majors enrolled in ten degree programs. The College of EMS offers ABET-accredited engineering degrees in civil, electrical, environmental, industrial, mechanical and software engineering, and engineering physics along with degrees in mathematics, broad field science, chemistry, computer science, microsystems and nanomaterials, and sustainable and renewable energy systems.

Industrial Engineering (IE) Program at UW-Platteville

The industrial engineering program at the University of Wisconsin – Platteville has been in existence since 1970, but it has been accredited by ABET since 1987. The ABET is a nonprofit, non-governmental organization that accredits college and university programs in the disciplines of applied science, computing, engineering, and engineering technology. ABET accreditation, which is voluntary and achieved through a peer review process, provides assurance that a college or university program meets the quality standards established by the profession for which the program prepares its students. The Bachelor of Science in Industrial Engineering (BSIE) degree requires a total of 129 to 132 semester credits must be completed. The program has four full time tenure-track faculty members. Description of courses and other details of the program are at http://www.uwplatt.edu/ie/. Currently there are about 143 students in the IE Program. The author has served the IE program at UW-Platteville in many different capacities from 1985 through 2014. He has used active experiential learning activities in his courses for the past few decades. This paper summarizes his experiences in using active experiential learning activities in a few of his courses.

Active Learning

In active learning, students in a classroom are more engaged in self or group learning activities rather than just listening. They may be engaged in dialog, debate, writing, and problem solving, as well as higher-order thinking[1]. According to Meyers and Jones[2] active learning involves providing opportunities for students to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject. Learning style models and theories show that learning is by nature an active endeavor and that different people learn in different ways. Research during the past few decades has established that

- individuals in small groups learn better than they do on their own or in isolation
- Students are not attentive to what is being said in a lecture 40% of the time
- Students retain 70% of the information in the first ten minutes of a lecture but only 20% in the last ten minutes.
- Students can recall only 8% more than students who had never taken the course.
- Students get lost in professors' drive to "cover all the material"

The website[3] provides a list of tools to support active learning. In engineering courses active learning activities may consist of demonstrations, graphics, video, animated tutorials, interactive tutorials or activities, drag & drop exercise, worksheets, web resources, online lecture notes, quizzes and exams. Active learning experience may be provided in many ways in engineering courses and Figure 1 below summarizes a few of them.

The instructor for a course must use what is appropriate for that course. The author formed teams of two students in his undergraduate courses, GENENG 2220 – Dynamics, GENENG 2820 – Engineering Economy, INDSTENG 3530 – Operations Research, and INDSTENG 4430 – Quality Engineering and used class participation activities to help students understand mathematical models, learn to use algorithms, and apply basic concepts to solve problems. In general class participation activity for students followed a lecture on a mathematical

model, equation, or concept and involved a targeted problem solving activity. The instructor moved around the classroom to help student teams with the active learning activity.

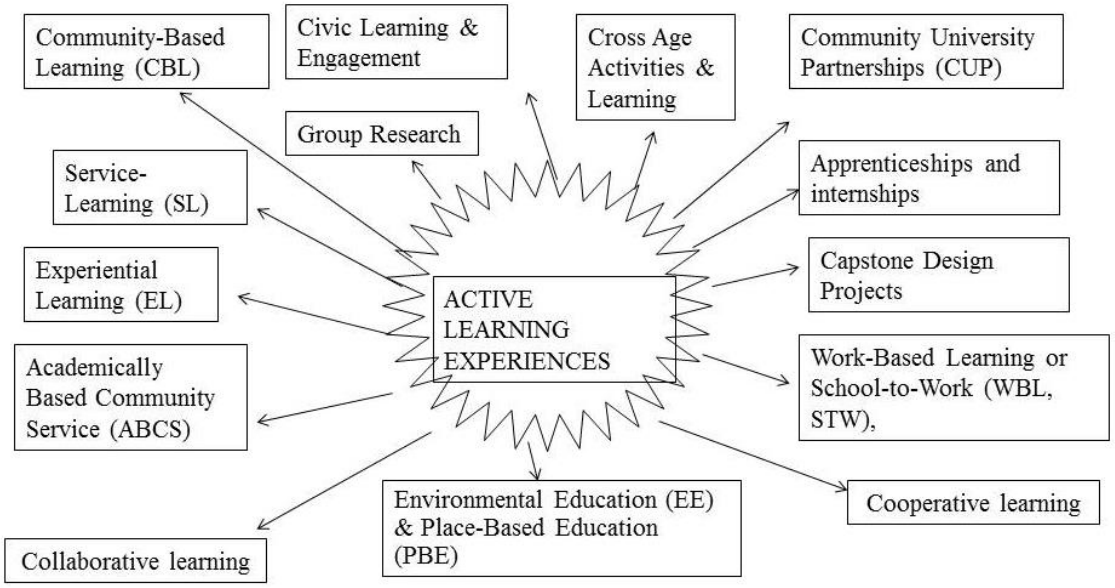

Figure 1. Active Learning Experiences

ABET criteria for accrediting engineering programs is process and student outcome oriented and it is critical for engineering programs to be able to demonstrate that student outcomes are attained. Active learning strategies increase student engagement with material and student work in active learning activities can be very powerful evidence to demonstrate that student outcomes are attained. The author's motivation for using active learning strategies in his courses may be summarized as:

- reduce the number of students dropping a course after a few weeks
- increase participation by students in learning activities in the classroom
- improve performance of students in tests
- enhance student understanding of mathematical models before applying them
- ensure that students know enough to be successful in the next course

Retention levels are enhanced when active learning methods are used and most students like it. Active learning leads to higher achievement, more positive relationships among students, healthier psychological adjustment, and recognition of abilities by peers.

Active Learning in GENENG 2820 – Engineering Economy

GENENG 2820 – Engineering Economy is a two-semester-credit course that is required in all engineering curricula. Many different types of cash flows, equations for computing discounted cash flow values, depreciation methods, after-tax cash flow analysis, and breakeven analysis are taught in this course. During three decades of teaching this course the author found that the first six week of the course were critical for students to learn the use of compound interest factors for single sum cash flow (P/F & F/P), uniform cash flow (P/A, A/P, F/A, A/F),

and arithmetic gradient cash flow (P/G, A/G). Weekly class participation activities were used to help students understand basic concepts and become familiar with the above compound interest factors and their use in solving typical problems. These class participation activities determined 5% of student grade, but reduced the number of students dropping the course at the end of the eighth week. The Table 1 is a summary of feedback from students in this course and they liked active learning activities in this course.

ASSESSMENT ELEMENT/FACTOR	Disagree Strongly/ Disagree	Neutral	Agree/ Agree Strongly
Class participation (CPP) problems were appropriate and relevant to the course	0%	4%	96%
CPP were too short	62%	38%	0%
CPP were too long	46%	38%	16%
CPP were useful to learn basic concepts		8%	92%
Increase number of CPP	35%	15%	50%
Decrease number of CPP	65%	23%	12%
CPP allowed me to do well in tests	12%	23%	65%

Table 1. Student Feedback: GENENG 2820 – Engineering Economy Course

Active Learning in GENENG 2220 – Dynamics

GENENG 2220 – Dynamics is a two-semester-credit course that is required in some engineering curricula. This course develops and uses many mathematical models for kinematics (rectilinear and curvilinear motion), Newton's equations of motion in one-, two-, and 3-diemensions, the principle of work and energy, and conservation of energy. During four decades of teaching at two different universities, the author found that the first six weeks of the course were critical for students to learn the basic concepts and models. Weekly class participation activities were used to help students understand basic concept and solve typical problems as a team with help from the instructor. These class participation activities determined 5% of student grade, but reduced the number of students dropping the course at the end of the eighth week. The Table 2 is a summary of feedback from students in this course and they liked active learning activities in this course.

Active Learning in Industrial Engineering Courses

The author has developed and used active learning in industrial engineering courses during the past three years. In each industrial engineering course, the author uses ten class

participation activities during a semester. Students form teams consisting two or three students and solve problems in class. The problems are structured to either review the course material that was covered in the previous week or to reinforce the basic concepts that were covered that week. In the engineering economy course problems dealt with different cash flows and economic criteria. In other courses problems dealt with either case studies or specific models. The class participation activities are scheduled either for the first day of a week or the last day of a week. Students appreciate these in-class activities as they are able to work as a team of two or three students and learn from one another. In addition, the instructor moves around the classroom providing timely help or checking the team work and correcting errors.

Summary and Conclusions

Active learning activities have been beneficial to both the instructor and students in every course. The instructor is able to use the class time effectively by using active learning activities to review course materials at the beginning of a week or lecture. Students appreciate active learning activities as they learn important concepts in a course by solving problems as a team with help from the instructor.

ASSESSMENT ELEMENT/FACTOR	Disagree Strongly/ Disagree	Neutral	Agree/ Agree Strongly
Class participation (CPP) problems were appropriate and relevant to the course	0%	6%	94%
CPP were too short	63%	31%	0%
CPP were too long	47%	50%	3%
CPP were useful to learn basic concepts		9%	91%
Increase number of CPP	9%	19%	72%
Decrease number of CPP	81%	19%	0%
CPP allowed me to do well in tests	9%	16%	75%

Table 2. Student Feedback: GENENG 2220 – Dynamics Course

References

1. Bonwell, C. C., and Eison, J. A. (1991). Active learning: creating excitement in the classroom, School of Education and Human Development, George Washington University.
2. Meyers, C., and Jones, T. B. (1993). Promoting active learning: Strategies for the college classroom. Jossey – Bass, San Francisco, CA.
3. http://info.piercecollege.edu/title3/aln.asp#