2006-1572: EXPERIENCE WITH INTERACTIVE METHODS IN MANUFACTURING COURSES

Jianmei Zhang, Kansas State University

Ms. J.M. ZHANG is a PhD student in Department of Industrial and Manufacturing Systems Engineering, Kansas State University, USA. And she passed her final examination for the Doctoral in February 2006 and will get her doctoral degree and graduate officially in May 2006. She holds Master's and Bachelor's degree in Mechanical and Electrical Engineering from Beijing University of Posts & Telecommunications in China. She has published over 15 papers at international and national conference proceedings and international journals.

Z.J. Pei, Kansas State University

Dr. Z.J. PEI is an associate professor in the Department of Industrial and Manufacturing Systems Engineering, Kansas State University. After receiving his Ph.D. in Mechanical Engineering from University of Illinois at Urbana-Champaign, he worked in industry for four years in the US. He holds three U.S. patents and has published over 30 journal papers and over 60 papers at international conferences.

Experience with Interactive Methods in Manufacturing Courses

Abstract

For the past several years, the authors of this paper have been teaching three manufacturing courses, including IMSE 250 Introduction to Manufacturing Processes & Systems (about 120 undergraduates per semester, twice a year), IMSE 564 Product and Process Engineering (about 25 undergraduates per semester, once a year), and IMSE 802 Semiconductor Manufacturing (about 10 graduate students per semester, one every three years). In all of these courses, the instructors implement interactive teaching methods intensively in order to increase the class participation, stimulate the students' learning interest, reinforce the important manufacturing concepts, and more importantly, help the students gain active-learning skills for their whole life. This paper will describe the different interactive teaching/learning methods the instructors implemented in these manufacturing courses and also share the experience when these approaches are applied.

Keywords

Engineering education; Manufacturing course; Interactive teaching; Active learning

1. Introduction

The authors have been teaching students manufacturing materials, during the past five years. And totally three manufacturing-related courses have been taught at Kansas State University. IMSE 250 Introduction to Manufacturing Processes & Systems is a required course for students majoring in industrial engineering, manufacturing systems engineering, and mechanical engineering. But some students are from other engineering disciplines, humanities and sciences. IMSE 250 is a large engineering class (about 120 students in fall 2005) and offered twice a year. IMSE 564 Product and Process Engineering is a required course for the students whose major is manufacturing systems engineering, and the students with other majors may take it as an elective. IMSE 564 is offered once a year to the senior undergraduates and there were 29 students in fall 2005. IMSE 802 Semiconductor Manufacturing is a graduate course offered once every three years. Normally there are about 10 graduate students. Most of them are majoring in Industrial Engineering, with some from other engineering disciplines.

The authors strive to improve their teaching skills continuously. Both authors actively participate in Kansas State University's LEA/RN, a program helping K-State Engineering faculty members learn how to teach effectively and how to apply active-learning strategies in their teaching. The first author is a member of K-State's WESP (Woman in Engineering and Science Programs) Learning Community and frequently attends teaching workshops and seminars. The authors applied teaching strategies and methods in their classes and continually adjusted them according to the students' responses and comments. The authors found that interactive teaching methods are very effective for students' learning no matter how large or small the class is. In next section, some interactive teaching methods will be described together with some feedbacks from the classes.

2. Six interactive teaching methods

TTYP In-class Discussion

According to the article "How the brain learns" authored by D.A. Sousa [1], different instructional methods generate different retention rates in brains. Compared with lecture generating 5%, group discussion generates 50%, and teaching others/immediate use of learning 90%, which can be achieved by TTYP effectively.

TTYP (Turn-To-Your-Partner) is the most often used interactive teaching method by the authors. It can be adjusted a little bit based on different manufacturing courses applied. In IMSE 250, most of students are freshmen and sophomores, and TTYP is given to reinforce students' understanding on the most important concepts for each lesson, and normally TTYP is given near the end of class. The instructors found the students' attention drops quickly after listening to 30-minute presentation. So TTYP can call back students' attention, give them opportunities to review the most important concepts during class which will increase their learning retention rate largely too. The instructors plan question for TTYP very carefully before class and the question should not be too difficult so the students can reach the right answer by thinking deeply and discussing with their peers. Students with a clear understanding of the material have an opportunity to strengthen their knowledge by explaining the concepts to students who might not understand the material. The latter students, then, also receive great benefit. And also, the teams who would like to share with the whole class and if they get the right answer, they can get extra credit for their reporting. In this way, students can participate in class discussion more actively and their interests of learning can be stimulated through getting "bonus." Besides the above, the instructors can have a very clear idea about where the students are currently, and have the instant opportunities to clarify the "muddy points" the students may have during class. It is a very important interactive method between the instructors and students and among the students.

For the other two manufacturing courses IMSE 564 and IMSE 802, the students are senior undergraduates or graduate students, they have considerable capabilities to learn and solve problems by themselves. TTYP in-class discussion changes a little bit in these two courses. Different reading material is assigned to different team members before class and during class, they are asked to do TTYP about what they learn from their own reading within their own teams. They learn deeply and think deeply while they teach others. After group discussion, the students are asked to put forward their questions. All the other students are encouraged to speak out their answers. Most likely, the students themselves can get the right answers by discussing and arguing with each other. Sometimes the instructors do provide some assistance or guideline in order for the students to deepen their thoughts and discussions. In this way, students' emotional involvement with the content is achieved, which is believed to have a remarkable influence on learning [2]. Through this kind of TTYP, students learn how to practice teamwork, get to realize the benefits of teamwork through their own practice and have the intention of doing teamwork, which is very important after they graduate. Through active learning, students learn, practice, and develop basic learning skills, which will benefit students most in their future.

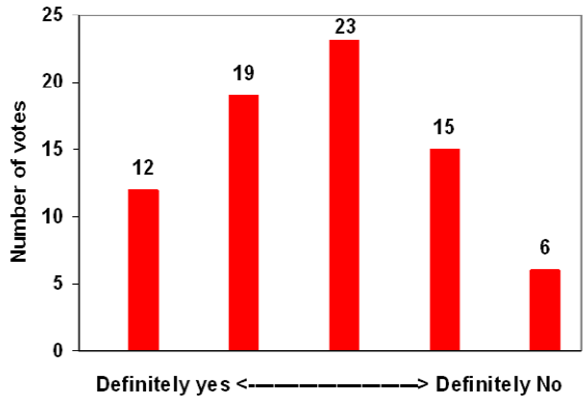
The students have very different opinions on TTYP. Some students like TTYP very much and some comments from them are listed as follows.

- "Keep doing the TTYP. It keeps the brain going."
- "Discussion (TTYP) help me to understand concepts better."
- "I enjoy the TTYP and also the extra credit. I know it makes me try harder because I know I could get extra credit."
- "I think TTYP is good because sometimes I am not sure by myself."
- "More TTYP time like 20 min/class."
- "TTYP are beneficial."

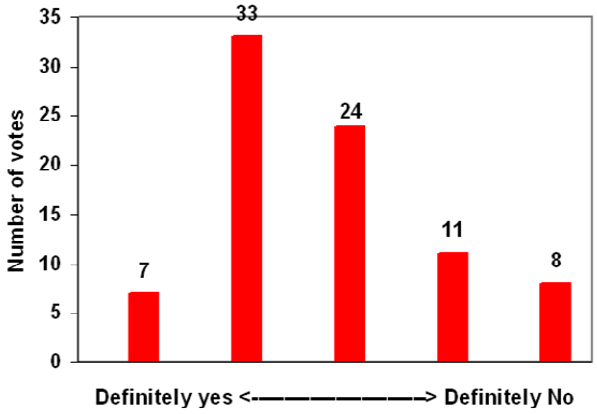
Some students do not like TTYP at all. Some examples of what they say are listed as follows.

- "I do not like the TTYP. I find it distracting."
- "For me the TTYP is a waste of time. I am getting nothing out of that exercise."
- "The TTYP's are not helpful to me."

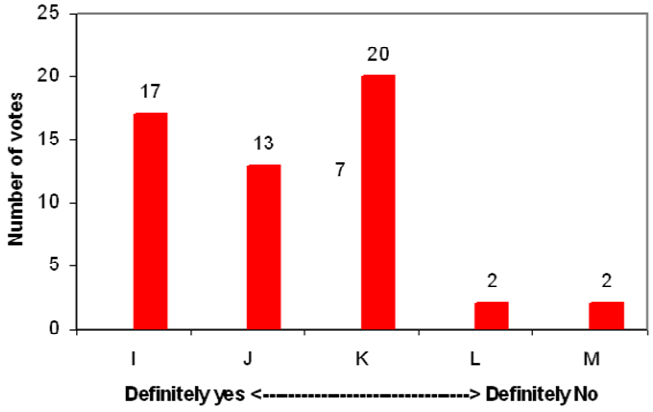
However, one survey question about TTYP was asked for several semesters: "we spend some time to have discussions and TTYP activities. Should I continue the practice next semester?" The corresponding answers from the students for three consecutive semesters are shown in Fig. 1. From these results, it is found that more and more students prefer to do TTYP and enjoy TTYP during class.



(a) Results from fall 2001;



(b) Results from spring 2002;



(c) Results from fall 2002;

Fig. 1. Survey results on TTYP from three consecutive semesters.

Short Questions

Short questions are prompted once or twice during each class. Normally before introducing important concepts, the instructors ask some short questions to catch students' attention and the students are forced to think about the questions and answer the questions. Their responses are always encouraged and no right or wrong judgements are given at that time. The students can get the right answers anyway after the related concepts are described. In this way, the students have more opportunities to do active thinking. Sometimes, the students are given questions before class and they enter class with their answers, so they are eager to seek the right answers and absorb the new knowledge.

Daily Quiz

Daily quiz is given every lecture for IMSE 250 only. The students are asked to take the quiz sheet when they enter the classroom for big class in order to save more time for lecture. Compared with TTYP focusing on the most important concept, daily quiz can highlight all the important concepts and knowledge students need to know and understand which can be used as a guideline for preparation of exam. Meanwhile, it can provide the responses from the whole class (only part of students' opinion is exposed from TTYP). When grading the daily quiz, the instructors can identify the "weak points" where the students do not get right, and explain these "weak points" to students' next class. In this way, no review section is necessary before each exam, since the problems have been addressed already after daily quiz. And also, daily quiz can help students concentrate on the lecture and catch their attention most of time. Daily quiz is also a good way to achieve high attendance rate.

Here are some comments on daily quizzes from the students. And almost every student like daily quizzes and for every class, the attendance rate is always over 85%.

- "The lectures in class are good. You learn a lot from these. Also, daily quizzes make you learn more about the class also makes you pay attention on."

- "The daily quizzes and videos are very helpful in retaining the information."
- "The quizzes and online homework help me learn better."
- "The daily quizzes to comprehend the important material."
- "Daily quizzes in class – easy but make us pay attention & learn."

Feedback and Muddiest points

The first author is a new instructor for IMSE 250 and she is trying hard to seek many ways to improve her teaching effectiveness. Regularly the students are asked for their comments and the "muddiest" points that they do not think they understand completely. This provides a valuable resource for the first author to learn how to improve her teaching and how to help students learn faster and better. The first author also invites some senior faculty members and colleagues into her class and asks them to give her additional feedback. The muddiest points from the students serve as the gage of her teaching effectiveness while some new teaching strategies are experimented during class.

Mid-term Survey

Mid-term survey provides good opportunities to interactive with students and to learn the responses from the students about the instructors' teaching effectiveness and teaching strategies applied in class. Although the students always have different opinions about teaching, statistical information can be revealed. Based on mid-term survey results, the instructors can adjust teaching strategies. Mid-term survey is like two-way street. Students give the instructors their opinions, and the corresponding changes are expected from the instructors. Mid-term survey can also demonstrate to the students that they are responsible for their own learning and their interests and desire of learning can be stimulated further.

The typical questions on the mid-term survey are shown as follows.

- "To help you learn better, the pace of the course should be made _____."
- "To help you learn better, you would like to have _____ homework assignments."
- "What activities are helpful to your learning that you would like me to **continue**?"
- "What activities are harmful to your learning that you would like me to **discontinue**?"
- "What activities might be helpful to your learning that you would like me to **start doing**?"

Online Message Board

Online message board is used intensively in courses IMSE 250 and IMSE 802. The extra credit activities are posted online and the students can answer these questions from message board. The instructors can also post their comments online corresponding to some students' answers. In this way, the students get assistance from the instructors by interaction with the instructors and seek the right answers successfully. Besides that, the students also are encouraged to post online their own questions and all the students are encouraged to post their answers freely. Message board is served as online-discussions between students, instructors, and the other professionals whom the instructors invite to participate online. They can answer the students' questions, and share their real world experience with the students.

In IMSE 250, online message board is used intensively as extra credit online activity tool. The instructors post some questions on the online message board, and the students are encouraged to browse the internet and the other resources like journals or textbooks to find the answers and post their solutions on the online message board. If some students get the right solutions, they will get extra credit for their participation.

During this semester (Spring, 2006), five online extra credit activities have been posted by the instructors and totally 90 postings have been received from the students, which means one student post about one posting on the message board within half of semester.

3. Conclusions

The authors have been inspired by the results of using these interactive teaching methods in their courses, especially the first author. The first author implemented these methods in her nine lectures during fall 2005 and very encouraging feedback on the mid-term survey was obtained, as shown in Fig. 2.

Fig. 2. Teaching effectiveness evaluation from mid-term survey.

Teaching evaluation from the IDEA (Individual Development Educational Assessment) Center of Kansas State University during fall 2005 is also very encouraging, as shown in Fig. 3. The IDEA center conducts the end-of-semester student evaluation every semester for this course. Among these three items, IDEA score on excellence of course has been improved from 3.7 during spring 2001 (the first semester the authors taught this course) to 4.5 during fall 2005. Results like these greatly encouraged the first author as an instructor and help give her the confidence and desire to do an even better job in teaching.

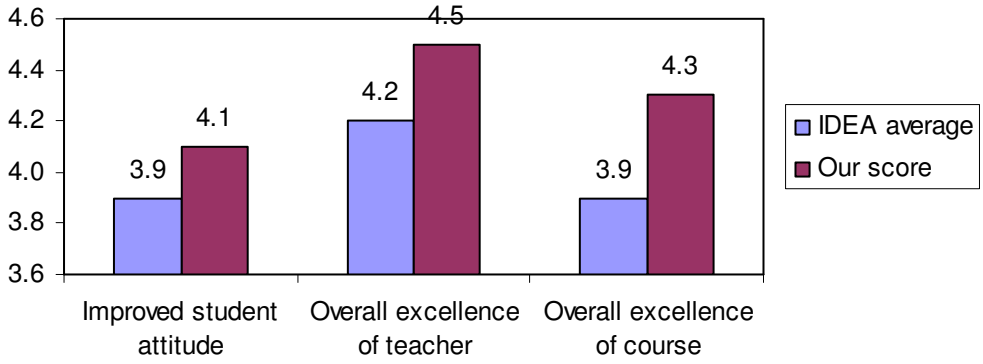


Fig. 3. IDEA score from Fall 2005.

References

[1] Sousa, D.A., (2001), *How the brain learns: a classroom teacher's guide*, Corwin Press, CA.
[2] Leamnson, R., (1999), Thinking about Teaching and Learning: Developing Habits of Learning with First Year College and University Students, Trenthan Book, England.