
AC 2011-135: DEVELOPMENT OF BEST PRACTICES FOR NEW ENGINEERING AND MATH EDUCATORS

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Abstract

The objectives of this study are to (1) provide new engineering and math educators with the best teaching practices and (2) document improvements in the effectiveness of mentee's teaching and in their student evaluation scores. The scope of the paper is limited to new educators' teaching effectiveness.

The innovative approach consisted of nine best practices. While these practices are not new, the way in which they are executed and integrated with each other is innovative.

The innovative strategy improved the teaching effectiveness of the new educators by 15% at a statistically significant level. The innovative strategy improved the new educators' student evaluations by 18.9% at a statistically significant level. Over the next five years, the authors plan to implement this strategy with more senior faculty and new educators. The method presented in this study may be used at other institutions with appropriate modifications in order to help new educators develop best teaching practices.

Introduction

There are many demands placed on new educators, including outstanding teaching, research, and service. Guidance, also known as mentoring, from senior faculty would ease the stress of meeting these demands by providing information about policies, introductions to others in the field, and offering teaching and research tips. The most common definition of mentoring is, "a relationship between an experienced, successful individual and a less experienced mentee whereby the latter receives guidance and advice from the former"¹⁻³. Several studies⁴⁻⁷ revealed many benefits of mentoring for both the mentors and the mentees. The benefits for mentees include: achieving new goals, remaining focused on school, receiving encouragement and support, work and career satisfaction, learning perspective and alternative solutions to their problems, less work and non-work conflict, and gaining individual recognition, confidence and self esteem. The mentor's role is to listen, refer, advise, help the mentee gain perspective, and to serve as a role model. Mentors and mentees discuss problems and recurring themes. The peer mentoring program is voluntary. Mentees who begin the peer mentoring program can opt out at any time. When the teacher quality improves, the students' achievements also improve⁸. Mentors feel an even greater commitment to engineering and enjoy the experience of helping others.

Objectives

The objectives of this study are to (1) provide new engineering and math educators with the best teaching practices and (2) document improvements in the effectiveness of mentee's teaching and in their student evaluation scores. The scope of the paper is limited to new educators' teaching effectiveness.

Motivation

The senior faculty member of this study has experienced the benefits of mentors through his own mentoring experiences with new faculty.

Methodology

The author invited the new engineering and math educators to observe his use of best practices in his classes. The author also made several unannounced visits to the classes of the new educators to observe, evaluate and advise them on effective teaching practices.

The innovative approach consisted of the nine best practices that are well established in the pedagogical literature. The author, a senior faculty, has an excellent teaching record. He has taught more than 3000 students in a wide variety of courses over the past 20 years, has won several outstanding teaching awards at the department and college levels, and has used over two dozen teaching practices. A representative sample of each of these practices was demonstrated before a class of 35 students (ENVT 845- The Environment). The instructor asked the students to rank the practices. The top nine were chosen for use in this study: (1) promoting a classroom atmosphere in which the students feel free to ask questions; (2) frequently posing probing questions to the students, with hints when needed; (3) increasing ability to analyze and critically evaluate ideas, arguments and points of view; (4) integrating labs with lectures; (5) providing the students with lecture objectives in each class; (6) thorough preparation for, and good organization of lecture; (7) providing useful feedback on exams, projects, and assignments; (8) maintaining course content that is consistent with the educational objectives of the course; and (9) facilitation of learning. While these practices are not new, the way in which they were executed and integrated with each other was innovative.

The way of integration of the nine best practices

The authors believe that if students do not learn the material it is because the teacher has not taught it well. Facilitation of learning (Practice 9) is, therefore, the most effective way of helping the student learn subject matter. The remaining eight practices were divided into five groups.

Group 1 consisted of Practices 1-3. A “do loop” was developed where Practice 1 fed into Practices 2 and 9, while Practice 2 fed into Practices 3 and 9, and Practice 3 fed into Practice 9.

Group 2 consisted of Practice 4, integrating labs into lectures. Group 1 fed into Group 2. In the traditional lecture method, labs are rarely integrated into lectures. To overcome this problem, a three step procedure was followed as explained in the “Implementation of the Strategy” section.

Group 3 consisted of Practices 5 and 6. Practice 5, providing lecture objectives, fed into Practice 6, excellent preparation and organization of the lecture.

Group 4 consisted of Practice 7, providing useful feedback on exams, projects, and assignments.

Group 5 consisted of Practice 8, tying course content with the educational objectives of the course.

Facilitation of learning, the Practice 9 consisted of the previous eight practices and an open ended component.

Implementation of the strategy

In Practice 1, the senior faculty member promoted an atmosphere in which the students felt free to ask questions. Several techniques were used including calling each student by his/her first name and sometimes acting funny (jumping on the table and announcing in a loud voice the most important concept, equation, or statistic of the day) while maintaining subject rigor. In the survey, several students reported that they felt free to ask even stupid questions sometimes. When a question was repeated, the instructor pretended that he was hearing the question for the first time. In fact, the instructor frequently announced that he would respond as if he was hearing the question for the first time even though it was repeated 50 times. The practice required that the instructor maintain eye contact and be respectful and gentle when correcting the mistakes of the students.

In Practice 2, the senior faculty member designed a series of questions with answers that built on previous answers. Each answer brought more knowledge by requiring the students to go deeper and deeper into the material. These questions were probing in nature but the instructor was careful to maintain a friendly atmosphere in the classroom.

In Practice 3, the instructor constantly pushed the analytical limits of the students by letting other students comment on answers in order to build their arguments. The instructor compared the level of answers given by the students before and after the application of critical evaluation of ideas, arguments and points of view. The instructor announced the improvements to the students.

In Practice 4, the instructor organized the lectures around lab dates. The day before the lab date, the objective, techniques, and application of the lab to real life experience were explained. This information was tied to the conceptual, qualitative, and quantitative portions of the lecture. On the lab date, the students got hands-on and minds-on experience in the lab. The next day Practices 1- 3 were applied to build on the lab topic.

In Practice 5, the instructor listed the educational objectives for the course at the beginning of the semester. The instructor listed lecture objectives at the beginning of each lecture. The connections among the lecture objectives within each class and among the classes were explained. The connections between the course objectives and lecture objectives were also explained.

In Practice 6, the instructor spent 3 hours preparing for and organizing of one hour of lecture. A power point presentation consisting of a flow chart that tied together topics and subtopics was created for each lecture. These presentations were strengthened by solving problems with detailed calculations on the black board. Students frequently participated in solving these problems by coming to the podium.

In Practice 7, the instructor provided useful feedback on exams, projects, and assignments. Except for the multiple choice questions, the instructor did not use teaching assistants for grading the exams, projects, and assignments. Feedback consisted of qualitative and quantitative written feedback on each item. The work was graded immediately and handed back during the next class. Students greatly appreciated the timely and useful feedback.

In Practice 8, the instructor made sure that the course content was consistent with the educational objectives of the course. He used resources other than the textbook, when appropriate, in explaining the course content. While covering the course content; he propelled the students to go well beyond average performance.

In Practice 9, the instructor facilitated learning by applying an open ended component that was designed to be dynamic (changing) in order to suit the mood, maturity, demography, and level of each class.

Results and discussion

Two confidential surveys were conducted. The first one consisted of the new educators' self evaluations of their effectiveness as teachers. The surveys were administered before and after use of the practices. The pretest scores showed an average rating of 81 and the post-test an average of 93. The innovative strategy improved the scores by 15%. With a calculated t value of 3.1 and degrees of freedom of 24, the results were significantly different. The t-test confirmed statistical improvement at a significant confidence level⁹⁻¹¹ with an alpha value of 0.05. The results are shown in Table 1.

The new educators ranked Practice 3 (increasing ability to analyze and critically evaluate ideas, arguments and points of view) the highest. The practice demonstrated 22.2% improvement. They felt this was the most important indicator of effective teaching. They ranked Practice 1, (promoting class atmosphere in which the students felt free to ask questions) as the least important. Practice 1 demonstrated 4.9% improvement. One reason for this could be the size of the class, 25 students. Practice 1 included addressing each student by name and remembering 25 names was difficult. During personal conversations with the educators, several commented that knowing every one's name is easy for a small class. Probably Practice 1 would not be ranked as the last one for small classes.

The second confidential survey was the students' evaluations of the new educators' teaching effectiveness. Before implementing the strategy, the evaluation scores were 74. The scores rose to 88 after the strategy was implemented. The innovative strategy improved the scores by 18.9%. With a calculated t value of 3.0, the groups are significantly different. The t-test confirmed statistical improvement at significant confidence level⁹⁻¹¹ with an alpha value of 0.05, and degrees of freedom of 24. The results are shown in Table 2.

The students ranked Practice 9, facilitation of learning, the highest. This practice demonstrated 29.8% improvement. They felt good when they got the best quality and quantity of knowledge for the money they paid. They ranked Practice 2, frequently posing probing questions to the students with hints when needed, last. This practice demonstrated 9.5 % improvement. This is

understandable because some students do not like probing questions even if the classroom atmosphere is congenial and learner-friendly.

During informal discussions the new educators stated that, since they were relatively inexperienced (average 1.2 years teaching) and had previously used traditional lecture methods, the improvements could be attributed to the innovative strategy. Prior to this study their teaching consisted primarily of monotonous lectures with frequent writing on the black board where they turned their backs to the students. However, the authors acknowledge that the improvements could be attributed, at least in a small part to the new educators' teaching experience.

The traditional lecture method (the control group) did not consist of any questionnaire on the 9 best teaching practices because these practices were absent. The 9 best of practices were applied in the experimental group. Therefore the average of the pretest scores in the control group were compared to the single-question posttest results of the experimental group.

Conclusions

1. The innovative strategy improved the teaching effectiveness of the new educators by 15% at a statistically significant level.
2. The new educators ranked Practice 3 (increasing ability to analyze and critically evaluating ideas, arguments and point of view) the highest.
3. The new educators ranked Practice 1 (promoting class atmosphere in which the students felt free to ask questions) as the least important.
4. Over the next five years, the authors plan to extend this strategy to more senior faculty and new educators. The method presented in this study may be used at other institutions, with appropriate modifications for the benefit of new educators.

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Table 1. t-test Results for new educators' self evaluation

Performance Index	Control Group Base value (%)	ITS Group (%)	Improvement (%)	t
1.Promoting a class room atmosphere in which the students felt free to ask questions	81	85	4.9	3.1
2. frequently posing probing questions to the students with hints when needed while teaching progresses	81	93	15.0	2.8
3. increasing ability to analyze and critically evaluating ideas, arguments and point of view	81	99	22.2	3.3
4.Integrating labs with lecture	81	95	17.3	2.2
5.Providing the student with lecture objectives in each class	81	92	13.6	3.6
6.Excellent preparation for and organization of the lecture	81	96	18.5	3.5
7.Providing useful feedback on exams, projects, and assignments	81	93	15.0	2.9
8.Maintaining the course content consistent with the educational objectives of the course	81	90	11.1	4.1
9.facilitation of learning	81	95	17.3	2.7
Average	81	93	15.0	3.1

ZTable 2. t-test Results for students' evaluation on the new educators' teaching effectiveness

Performance Index	Control Group Base value (%)	ITS Group (%)	Improvement (%)	t
1.Promoting a class room atmosphere in which the students felt free to ask questions	74	89	20.2	2.3
2. frequently posing probing questions to the students with hints when needed while teaching progresses	74	81	9.5	3.1
3. increasing ability to analyze and critically evaluating ideas, arguments and point of view	74	83	12.1	2.6
4.Integrating labs with lecture	74	88	18.9	2.9
5.Providing the student with lecture objectives in each class	74	85	14.9	3.3
6.Excellent preparation for and organization of the lecture	74	96	18.5	3.4
7.Providing useful feedback on exams, projects, and assignments	74	93	25.6	2.7
8.Maintaining the course content consistent with the educational objectives of the course	74	88	20.2	2.9
9.facilitation of learning	74	96	29.8	3.6