Assessing the effectiveness of a faculty instructional development program part 2: teaching and learning styles

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ABSTRACT: This paper discusses the effectiveness of the Faculty Instructional Development Program in the College of Engineering at San Jose State University, in meeting its objective to *"introduce, promote, and implement a variety of teaching methods that address the diverse learning styles of our students"*. Engineering students show strong preferences in active, sensing, visual and inductive learning. On the other hand, traditional teaching styles tend to favour reflective, intuitive, verbal and deductive learning styles. A faculty survey was conducted to study the teaching styles of our faculty. The results show that the Faculty Instructional Development Program has indeed a strong impact in sensitising our faculty to the need for variety of teaching methods. This is important for three reasons. First, students do not learn effectively when a course is presented entirely in ways opposite to their preferred learning styles. Second, students do not develop as balanced learners when a course is presented entirely in ways that favour only their preferred learning styles. Third, research has shown that traditional teaching methods cannot produce engineering graduates capable of meeting the demands likely to be placed on them in the coming decades.

THE FACULTY INSTRUCTIONAL DEVELOPMENT PROGRAM [1]

The Faculty Instructional Development Program (FIDP) was initiated in 1995, with the goal of creating a learning community within the College of Engineering (COE). It is hoped that the presence of a learning community among the faculty will lead to an improved instructional environment, which meets the needs of our diverse community of students. Specifically, the objectives of the program are to:

1. Foster a reflective attitude towards teaching and learning.
2. Introduce, promote and implement the use of a variety of teaching methods (such as, but not limited to, active and cooperative learning, project and problem-based learning) to address the diverse learning styles (LS) of our students.
3. Introduce, promote and implement the use of multi-media in engineering instruction, including the worldwide web.
4. Promote teamwork and leadership in instructional development, by encouraging interested faculty to become mentors / coaches for their peers in any area related to innovative pedagogy and the use of technology.
5. Promote the scholarship of teaching in engineering.

A previous paper [2] discussed the adoption and adaptation by the faculty of active and cooperative learning methods. In this paper, we discuss the progress in promoting a variety of teaching methods to address the diversity of student LS.

Two indicators will be used to assess the effectiveness of the FIDP in regards to meeting its second objective.

1. The percent of faculty who have become familiar with the concept of student LS.
2. The percent of faculty who currently use enough variety in their teaching methods to address the LS of most engineering students.

LEARNING STYLES

A student's learning depends on many variables. The most important ones are native ability, experience, motivation and attitude towards learning. However, research has shown that learning also depends on how well a student's LS is matched by our teaching style [3].

Learning style is a student's consistent way of responding to and using stimuli in the context of learning. Understanding our own LS is the first step towards becoming lifelong learners. There are many models of LS in the literature. The most relevant ones for engineering education are summarized in reference [4]. The model that has been used in this study is the Felder-Silverman [3,4]. According to this model, there are five dimensions to learning and learners are classified in each one of these dimensions as follows:

1. *Perception: What type of information does the student prefer to perceive?*
   a. Sensing learners: prefer concrete, practical information and are oriented towards facts and procedures.
   b. Intuitive learners: prefer concepts, tend to be more innovative and are oriented towards theories and meanings.
2. *Input Modality: Through what sensory modality is sensory information perceived more effectively?*

   a. Visual learners: prefer visual representations of presented material.
   b. Verbal learners: prefer written or oral explanations.
3. *Organization: How does the student prefer the information presented to be organized?*
   a. Inductive learners: prefer presentations that proceed from specific to general.
   b. Deductive learners: prefer presentations that go from general to specific.
4. *Processing: How does the student prefer to process information?*
   a. Active learners: learn by trying things out, working with others.
   b. Reflective learners: learning by thinking things through, working alone.
5. *Understanding: How does the student progress towards understanding?*
   a. Sequential learners: tend to be linear and orderly, learn in small incremental steps.
   b. Global learners: tend to be holistic, system thinkers, learn in large steps.

The Felder-Silverman Learning Styles Inventory (LSI) [5] assigns a numerical score to a student based on the answers to various questions. The score can range from (-11) to (+11) along an axis for each of the five dimensions above. For example, along dimension 2, Input Modality, students are rated from (-11), which indicates extreme preference for visual learning, to (+11), extreme preference for verbal learning. According to the model, scores between (-3) and (+3) indicate learners who are fairly balanced in the particular dimension. Students in several engineering classes have taken the LSI online over the last five years. The results from 3 courses are summarized in table 1.

Table 1. Learning styles of engineering students at SJSU.

MatE 153 N=261			ME111 N=196	E10 N=693
Active	60	23%	68 (35%)	187 (27%)
balanced	*157*	*60%*	*108 (55%)*	*421 (61%)*
Reflective	44	17%	20 (10%)	85 (12%)
Sensing	112	43%	87 (44%)	239 (34%)
balanced	*136*	*52%*	*92 (47%)*	*357 (52%)*
Intuitive	13	5%	17 (9%)	97 (14%)
Visual	149	57%	120 (61%)	368 (53%)
balanced	*94*	*36%*	*70 (36%)*	*310 (45%)*
Verbal	18	7%	6 (3%)	15 (2%)
Sequential	81	31%	48 (24%)	196 (28%)
balanced	*151*	*58%*	*122 (62%)*	*446 (64%)*
Global	29	11%	26 (13%)	49 (7%)
			N=159	N=93
Inductive	N/A	N/A	68 (43%)	35 (38%)
balanced	*N/A*	*N/A*	*46 (29%)*	*46 (49%)*
Deductive	N/A	N/A	45 (28%)	12 (13%)

It should be noted here that the LSI does not measure preference in the inductive/deductive dimension. The data in the last three rows were collected in class. Students were

Table 2. Teaching and learning styles matrix.

presented information on the same topic first deductively, then inductively, and were asked to indicate which approach helped them understand the topic better.

The data shows that for the most part, engineering students at SJSU are fairly balanced learners in all five dimensions. However, the data also shows that large percentages of engineering students prefer active, sensing, visual, sequential, and inductive learning. These results are consistent with data taken at other engineering institutions [6-8].

TEACHING STYLES

Table 2 shows several teaching practices along with the corresponding LS addressed by each of these practices. For example, the traditional lecture, which involves mostly writing on the board accompanied with oral explanation of the material presented, accommodates only the verbal LS. On the other hand, hands-on design projects done cooperatively in teams address all LS.

There are 3 reasons why variety in teaching methods is important:
(a) Students do not learn effectively when a course is presented entirely in ways opposite to their preferred LS. Traditional teaching styles, with extensive emphasis on lecturing and derivations, lack of visual aids in presentations, and lack of hands-on projects, tend to favor reflective, intuitive, verbal and deductive LS.
(b) Students do not develop as balanced learners when a course is presented entirely in ways that favor only their preferred LS. This can be detrimental in their development as lifelong learners.
(c) Research has shown that traditional teaching methods cannot produce engineering graduates with the attributes required by ABET EC 2000 [9] and capable of meeting the demands they will most likely face in the coming decades [10], while alternate teaching methods offer good prospects for doing so. These methods include appropriate course design with clear and measurable learning objectives, established relevance of course material to practical applications, a balance between concrete and abstract information, and extensive use of active, cooperative, and problem-based learning [11].

FACULTY WORKSHOPS

The COE at SJSU has 83 tenured/tenure-track professors. There are more than twice as many lecturers from local industry, who teach on a temporary contract basis. A few of these lecturers hold full-time appointments.

Table 3 presents a summary of the teaching effectiveness workshops, offered through the FIDP and the University Center for Faculty Development & Support (CFDS), from 1995 through Fall 2002. From the CFDS workshops, only engineering professors were included in this table. The usual duration for each workshop is two hours.

Teaching Practices	VER	VIS	SEN	INT	ACT	REF	GLO	SEQ	IND	DED
1. "Traditional" lecture	O									
2. Lecture including other activities					O					
3. Use of a projector to present equations and text.	O							O		O
4. Use of a projector to present visual information (pictures, diagrams, etc.).		O	O	O						
5. In-class demonstrations.		O	O						O	
6. In-class computer activities.						O				
7. In-class small group activities.	O				O	O				
8a. Start with simple examples, continue with more complex examples, and move towards generalized principles / theorems.			O						O	
8b. Start with general principles, simplify, then present specific examples.				O						O
9. Assign individual homework.	O			O	O	O		O		
10. Assign homework to be done in teams.	O			O	O	O		O		
11. Assign hands-on design projects.	O	O	O	O	O	O	O	O	O	O
12. Use email to communicate with class.	O									
13. Use a web page to communicate with class	O	O								
14. Use detailed learning objectives in each class.	O	O	O	O	O	O	O	O	O	O
15. Give study guides before tests.	O	O	O	O	O	O	O	O	O	O
16. Solicit feedback from students on what works well in class and what does not.	O	O	O	O	O	O	O	O	O	O

However, the COE introduced in 2001 an annual, full-day workshop, which combines several subjects (cooperative learning, learning/teaching styles, Bloom's taxonomy/ instructional objectives). The primary target audience for this workshop is the new engineering faculty, although many experienced professors have chosen to participate in the first two offerings.

Table 3. Teaching effectiveness workshops offered through University and COE programs from 1995 through Fall 2002.

Date of 1st offering	Workshop title and times offered	No. of participating engineering faculty
Spring 1995	Cooperative Learning = 8	73 FT (88%) + 26 PT
Spring 1996	Conditions of Learning = 6	17 FT (20%) + 14 PT
Fall 1998	Learning & Teaching Styles; The Felder-Silverman Model = 10	32 FT (39%) + 24 PT
Spring 2000	Bloom's Taxonomy & Instructional Objectives = 5	29 FT (35%) + 21 PT
Spring 2001	Learning & Teaching Styles; The Kolb Learning Cycle = 2	1 FT (1%) + 1 PT

Learning styles are not the main focus of all the workshops. However, many of them provide experience in developing instructional methods that may address a variety of LS. Almost all the full-time, tenure-track professors have attended at least one teaching effectiveness workshop and a few have participated in all. On the other hand, of the part-time instructors, only 30 (approximately 18%) have attended at least one workshop. Table 3 also shows that the majority of full-time engineering professors have been exposed to cooperative learning, while 39% have been introduced to the Felder-Silverman model of LS.

Table 4. Faculty survey on instructional methods

In addition to the workshops, the FIDP offers opportunities for discussions on a variety of teaching-related issues every month, in a series under the title *"Conversations on Teaching"*. These gatherings promote informal interaction among the participants and are essential to meeting the goal of the FIDP, *'to create a learning community within the COE for the purpose of improving instruction'*.

FACULTY SURVEY OF TEACHING STYLES

In Fall 2001, a survey was sent to all professors in the COE. The demographics of the respondents are as follows:
Twenty-seven (27) surveys were returned, 17 from tenured / tenure-track faculty (20% of the total in the COE) and 10 from part-time faculty (5% of the total in the COE). The responders included:

- 10 lecturers, 6 assistant professors, 3 associate professors, and 8 full professors, at the time the survey was sent.
- 12 (44%) with more than 10 years of teaching experience, 5 (19%) with 6-10 years, 3 (11%) with 3-5 years, 4 (15%) with 1-2 years, and 3 (11%) with less than a year of teaching experience.

More than half of the participants (15) had taught at other institutions in addition to SJSU. Table 4 shows the statements / questions included in the survey.

1. I lecture for most of each class period: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
2. I lecture *for only part* of the class period: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
3. I use an overhead or a computer projector to present equations and text: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
4. I use an overhead or a computer projector to show pictures, diagrams, sketches, flow charts, plots, schematics or other visual information: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
5. I perform in-class demonstrations: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
6. My students perform in-class computer activities: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
7. I use in-class small group (cooperative learning) activities: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
8. When I introduce complex principles or theorems in my classes: I usually start with (a) specific examples that are easy to grasp, continue with more complex examples, and finally generalize the principle **or** (b) the general principle, continue by making simplifying assumptions, and finally, present specific examples.
9. I assign homework problems to be done individually: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
10. I assign homework problems to be done in teams: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
11. I assign hands-on design (or other open-ended) projects: (a) in every course I teach (b) in some courses (c) never
12. I use email to send messages to my entire class: (a) once or more times a week (b) once or more times a month (c) once or more times a semester (d) never.
13. I use a web page to communicate with my class: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
14. My list of learning objectives (LO) for each class I teach usually has: (a) 10 or fewer LO (b) 11 to 25 LO (c) 50 or more LO
15. I give study guides to students before tests: (a) always (b) usually (c) sometimes (d) never
16. I solicit feedback from my students on what works well for them in my classes (i.e., lectures, text, homework, lab, etc.) and what doesn't: (a) in every class section (b) once or more times a week (c) once or more times a month (d) once or more times a semester (e) never.
17. I discuss teaching with my colleagues: (a) once a week (b) every 2 weeks (c) once a month (d) once a semester (e) once a year (f) never.

FACULTY SURVEY RESULTS AND DISCUSSION

Faculty responses to the survey are summarized in table 5. In interpreting these results, one must keep in mind that the respondents are not truly representative of the general faculty population. Most of them have been regular participants in teaching effectiveness workshops and place a high priority on teaching. Nevertheless, careful examination of the data in table 5 shows trends similar to those observed at other institutions [12].

❖ 70% of the respondents lecture for most of each class period, while 33% allow for other activities in the classroom, at least once a week. Considering the well-known limitations of lecturing, this result shows that most engineering professors, including those who place a high priority on teaching, do not yet feel comfortable with alternate teaching methods in the classroom, despite their proven effectiveness.

❖ 39% of the respondents use a projector to show visual information in every class session, while another 26% does so at least once a week. Considering the fact that more than half of our students are visual learners (table 1), this practice enhances the learning process of a significant number of students.

❖ 34% of the respondents use small group activities in their classes (ex. problem solving), at least once a week. Again, considering the well-documented benefits of active and cooperative learning [2], this result reveals that most engineering faculty do not yet feel comfortable giving their students more responsibility for their own learning.

❖ 35% of the respondents discuss teaching with their colleagues at least every other week, while another 26% discuss teaching at least once a month. This observation is significant because it is usually through these conversations (informal or formal) that professors exchange ideas about teaching and are encouraged to try new methods in their classes.

CONCLUSION

In summary, the FIDP has succeeded in introducing the concept of LS to the engineering faculty at SJSU. In addition, it has succeeded in introducing and promoting a variety of proven teaching methods that address the needs of students who show preference in any of these LS. A significant number of engineering professors have already adopted some of these methods in their classes. This is important not only for the reasons discussed earlier (enhancing student learning and producing lifelong learners) but also because, as the authors in reference [10] conclude, *"traditional teaching methods will probably not be adequate to equip engineering graduates with the knowledge, skills, and attitudes needed to meet the demands likely to be placed on them in the coming decades, while alternative methods that have been extensively tested [11] offer good prospects of doing so".*

Table 5. Results of the faculty survey on instructional methods. The numbers in the left column correspond to survey statements.

Instructional method	In every class session	Once or more times a week	Once or more times a month	Once or more times per semester	Never
1	16 (70%)	5 (22%)	0	2 (8%)	0
2	3 (13%)	5 (22%)	9 (39%)	2 (8%)	4 (17%)
3	7 (30%)	4 (17%)	8 (35%)	1 (4%)	3 (13%)
4	9 (39%)	6 (26%)	3 (13%)	3 (13%)	2 (8%)
5	0	5 (22%)	6 (26%)	8 (35%)	4 (17%)
6	4 (17%)	2 (8%)	4 (17%)	6 (26%)	7 (30%)
7	4 (17%)	4 (17%)	5 (22%)	3 (13%)	7 (30%)
9	6 (26%)	11 (48%)	2 (8%)	2 (8%)	2 (8%)
10	0	4 (17%)	5 (22%)	8 (35%)	6 (26%)
12	N/A	7 (30%)	3 (13%)	6 (26%)	7 (30%)
13	6 (26%)	5 (22%)	4 (17%)	2 (8%)	6 (26%)
16	0	2 (8%)	5 (22%)	13 (57%)	3 (13%)
8a	10 (43%)				
8b	12 (52%)				
11	In every course I teach = 11 (48%)			In some courses = 9 (39%)	Never = 3 (13%)
14	10 or fewer LO = 10 (43%)	11 to 25 LO = 11 (48%)		More than 50 LO = 2 (8%)	
15	Always = 7 (30%)	Usually = 3 (13%)	Sometimes = 8 (35%)		Never = 5 (22%)
17	Once a week = 3 (13%)	Every 2 weeks = 5 (22%)	Once a month = 6 (26%)	Once every semester = 7 (30%)	Once a year = 0

On the other hand, many engineering faculty still hesitate to use new teaching methods, despite extensive evidence regarding their effectiveness in satisfying key requirements for engineering graduates [10,11]. It is hoped, that the pressure to meet ABET EC 2000 [9], will gradually result in a change of the current climate and convince more faculty to adopt new teaching methods.

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