Engineering Faculty Teaching Styles and Attitudes toward Student-Centered and Technology-Enabled Teaching Strategies

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Abstract

This paper presents results of a survey assessing learning preferences and teaching strategies of engineering faculty. Of particular interest were questions pertaining to technology implementations and to professional development. The survey pointed to lack of interest in educational activities and low use of innovative instructional methods and instructional technologies, particularly among junior engineering faculty. Results of a recent national faculty survey are reviewed to provide the context for discussion. Professional development of engineering faculty, long an area of concern, becomes more urgent as accumulated applied engineering and teaching experience is being lost through impending retirements. Ironically, with faculty renewal, there is a risk of the dominant culture in engineering departments becoming even less responsive to students' needs. Such concerns have been highlighted before and this study confirms them.

I. Introduction

Background

This paper is a follow-up to a previous study[1, 2] of the relationship between learning styles and academic achievement in a hypermedia-enhanced learning environment. A majority of engineering students in the 2000-2002 study were Active, Sensing, Visual, and Sequential learners, according to the Felder Learning Styles Model[3, 4]. The model focuses on aspects of learning styles significant in engineering education. Its associated psychometric instrument, the Index of Learning Styles[5], assesses four modalities: Processing (Active/Reflective), Perception (Sensing/Intuitive), Input (Visual/Verbal), and Understanding (Sequential/Global). The model provides insight into how teaching strategies can be modified to broaden their appeal to a larger cross-section of the student population. To increase the support for learners with different individual preferences, Felder advocates a multi-style approach to science and engineering education and incorporation of active, experiential, collaborative student-centered learning[6], an approach long advocated as an effective learning environment for engineering education[7, 8, 9].

Teaching style dominant in engineering departments can be best described as instructor-centered and traditional[7, 10, 11, 12]. It is based on lectures that tend to be Verbal (“chalk & talk”), Intuitive (abstract theory) and Reflective (little student feedback), and offers little support for active, collaborative learning. Many students do not learn well in such environment and thus may be disenfranchised. The author used hypermedia-enhanced instruction in order to provide scaffolding for such students[1, 2]. The objective of this study was to verify the assertion regarding the traditional learning-teaching environment and thus to provide a qualitative context for the previous study.

II. Methods

In September 2002, an Instructor Survey questionnaire was mailed out to all full-time faculty members in the Faculty of Engineering and Applied Science at Ryerson University, in Toronto, Canada. Participation in the survey was voluntary and anonymous. Participants were not exposed to any risks or reprisals for refusal to participate, nor did they receive any incentives or rewards for completing the survey. The survey consisted of 2 demographic items, 30 questions regarding the use of instructional strategies and instructional technology with a four-point Likert scale, the ILS questionnaire, and a “checklist” of views on the teaching and learning process, adopted from Valcke[14]. Reliability analysis of Likert-scale items yielded an internal consistency estimate of Cronbach's alpha equal to 0.7964, meeting the generally accepted criteria[15, 16]. Before the survey was conducted, summary data from the administration was secured, reporting the numbers of faculty employed in each of the teaching departments within the Faculty of Engineering and Applied Science (FEAS), and their years of employment at the University.

III. Results and Discussion

Response Rates

Overall, 48 out of 176 teaching faculty responded (27.3% return rate). The rates across different departments varied from a low of 14% in Mechanical, Industrial & Aerospace Engineering, to a high of 64% in Electrical and Computer Engineering (ELCE). FEAS has undergone a massive faculty renewal, with 95 new faculty hired in the last five years, accounting for 54% of the total. Very few of those were senior faculty with significant prior experience. Thus, it was assumed that the self-declared years of teaching experience in the survey corresponded to employment seniority information provided by the University. Figure 1 shows the demographic breakdown of the survey responses. The response rate for *junior* faculty members, defined as those with less than 5 years of experience was only 13.7% overall. This compares with a 43.2% rate for *senior* faculty members, defined as those with more than 5 years of experience. The response rate for faculty with over 20 years of teaching experience was even higher, at 64%.

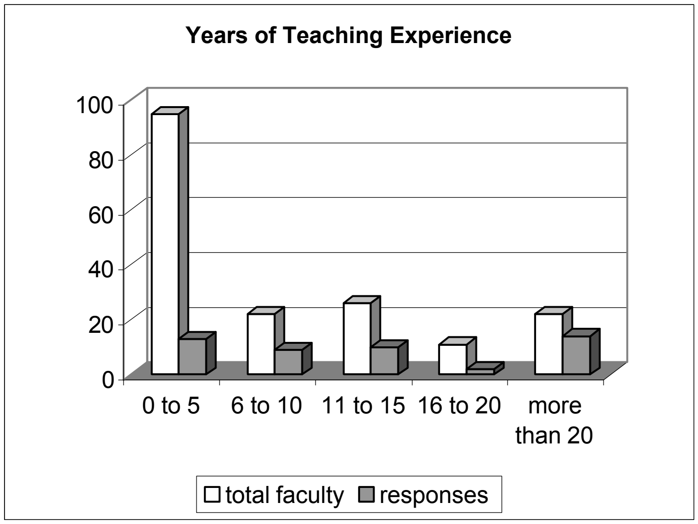

Figure 1: Responses for Groups with Different Teaching Experience across FEAS, Ryerson Faculty Survey, 2002

Institutional Context for the Faculty Survey

An institutional context also needs to be set. As of 2002, the membership of Ryerson Faculty Association (RFA) counted 526 individuals, 300 of whom (or about 57% of the total) have been hired since 1996, with FEAS accounting for almost 40% of that number[17]. FEAS faculty comprises 33% of all RFA members. FEAS has established a highly visible profile within the University with respect to the number of research grants, graduate programs, publications, etc. However, the same cannot be said for participation in educational professional development or instructional technology use. Benchmarks for these are provided by a look at the activities of the Learning & Teaching Office (LTO) at Ryerson (http://www.ryerson.ca/lt/about/index.htm) and of the Digital Media Projects (DMP) (http://www.ryerson.ca/dmp/). The former provides support and resources to faculty in their teaching, in close collaboration with the latter, supporting the effective use of new media for instruction. Services include education seminars and workshops, technical support, project management and training. Table 1 shows data obtained from the LTO regarding faculty participation in Annual Faculty Conferences and in workshops for the newly hired faculty. Average participation rate of engineering faculty in Annual Faculty Conferences was 8.8%, as compared with the 33% share of the faculty complement. Similarly, engineering faculty comprised only 23.2% of the participants of the new faculty workshops, as compared with their 40% share of the new hires. Admittedly, data with respect to the new faculty training is more difficult to interpret since the workshop attendance was open to all new instructors and not just those hired in a particular year. However, the ratio of workshop participants to the total number of newly hired faculty was equal to 0.64 for FEAS, as compared with the 1.57 ratio for all others, a participation rate of only half of that for other faculties within the university.

Table 1: Engineering Faculty Participation Rates in LTO Events

Annual Faculty Conferences						
	Total No.	1999	2000	2001	2002	Average %
FEAS	176 (33%)	25 (12.1%)	19 (9.8%)	9 (4.6%)	17 (8.0%)	8.8%
Other Faculties	350 (67%)	181 (87.9%)	173 (92.2%)	177 (95.4%)	196 (92.0%)	91.2%
Overall	526 (100%)	206 (100%)	192 (100%)	186 (100%)	213 (100%)	100%
New Faculty Workshops						
	New Hires	1999	2000	2001	2002	Average %
FEAS	118 (40%)	8 (22.8%)	23 (27.4%)	21 (13.5%)	24 (27.6%)	23.2%
Other Faculties	182 (60%)	27 (77.2%)	61 (72.6%)	135 (86.5%)	63 (72.4%)	76.8%
Overall	300 (100%)	35 (100%)	84 (100%)	156 (100%)	87 (100%)	100%

According to the DMP statistics for 2002, out of approximately 2,200 courses offered in full-time programs at Ryerson, close to 350, or 16%, use the WebCT web site management software. While FEAS constitutes 20% of the university enrollment, in 2002 there were only five WebCT-supported engineering courses. Notwithstanding the fact that some engineering courses use the Internet and CD-ROMs outside the WebCT, this indicates a level of penetration of technology-assisted teaching in FEAS significantly below the norm for Ryerson University.

Learning Styles of Engineering Faculty

Most academic teachers lack formal educational training[18]. They do not to reflect on their teaching and follow familiar patterns[19, 20], teach in their "native" style, correlated with their personality traits[21, 22] and aligned with traditional teaching to which they were exposed while in college[7, 10,23]. Table 2 shows that engineering faculty members have predominantly Reflective, Intuitive, Global and heavily Visual learning preferences.

Table 2: Differences in Distributions of Modalities between Students (n =338) and Faculty at Ryerson University (n =48)

	N	Ref.	Act.	Int.	Sen.	Verb.	Vis.	Glo.	Seq.
FEAS 2002	48	62.5%	37.5%	58.3%	41.7%	6.2%	93.8%	64.6%	35.4%
Students (2000-2002)	338	39.1%	60.9%	35.2%	64.8%	11.8%	88.2%	37.3%	62.7%
Chi-Square Statistic		χ^2 =11.087, df=1, p=0.001**		χ^2 =11.254, df=1, p=0.001**		χ^2 =1.435, df=1, p=0.231		χ^2 =15.306, df=1, p=0.0005***	

**Statistically significant at 0.01 level, 2-tailed; ***Statistically significant at 0.001 level, 2-tailed.

Except for the Visual preference, the faculty profile is an exact opposite of the profile of student learning preferences. Three out of four Chi-Square statistics for differences in student-professor distributions of the model scales are statistically significant. As well, Table 3 shows statistically significant differences for those scales in the means between the surveyed faculty and the students in the study. Figure 2 shows differences in distributions between the learning style groupings (out of 16 possible style combinations) among engineering faculty (n =48), as compared with engineering students (n =338). Among faculty, the two predominant style combinations are RIViG, and AIViG, which account for 46% of the total, while among students, the two predominant combinations (40% of the total) are ASViS and RSViS. The RIViG and AIViG groups were most likely even more dominant among the faculty, since they accounted for 57% in ELCE, where the survey return rate was the highest (64%). The Chi-Square statistic for the differences in distributions of the first eight style combinations that account for over 88% of all students and over 92% of all faculty, is statistically significant at 0.001 level, 2-tailed (χ^2 =36.245, df=7, p=0.0003).

Table 3: Means, Standard Deviations and ANOVA Results for Comparisons between Students and Professors in ILS Scores

Populatio n	Sample	Active Score		Sensing Score		Visual Score		Seq. Score	
		Mean	STD	Mean	STD	Mean	STD	Mean	STD
Students	338	6.03	2.38	6.46	2.55	8.09	2.11	5.95	2.11
Professors	68	4.88	2.15	4.75	2.88	8.01	2.15	4.99	2.22
ANOVA statistic		F = 13.603, df = 1, 404, p = 0.000***		F = 24.547, df = 1, 404, p = 0.000***		F = 0.064, df = 1, 404, p = 0.801		F = 11.540, df = 1, 404, p = 0.001**	

**Statistically significant at 0.01 level, 2-tailed; ***Statistically significant at 0.001 level, 2-tailed.

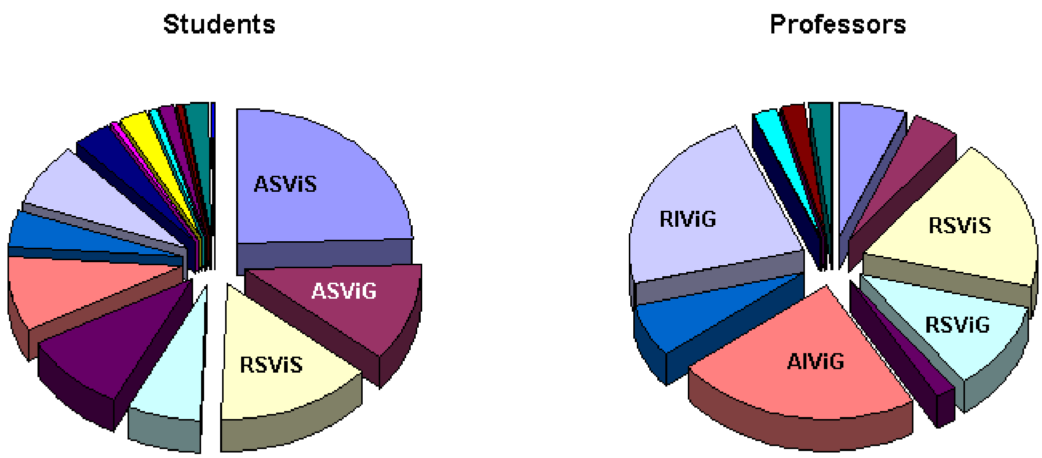

Figure 2: Differences in Distributions of 16 Styles between Engineering Students (n =338) and Engineering Faculty (n =48) at Ryerson

Teaching Strategies of Engineering Faculty

Table 4 summarizes survey responses to questions regarding participation in instructional development activities. The survey return rate was particularly high (64%) in the Department of Electrical and Computer Engineering (ELCE). Consistency of the responses between ELCE and the rest of the Engineering faculty supports the accuracy of the survey. Table 4 shows low participation rates in instructional development activities, with over 60% of the survey respondents reporting not having participated in any instructional development activities, consistent with low participation of engineering faculty in workshops and annual conferences as reported by the LTO (see Table 1). The participation in educational workshops is marginally better for junior faculty (with less than 5 years of experience) than for their more experienced colleagues (Table 5). This is probably a result of the LTO workshops geared expressly toward the new faculty.

Table 4: Instructional Development Activities: ELCE vs. FEAS

	None	One	Two	3 or More
Attended workshops in a year (all FEAS n=48)	61%	25%	6%	8%
Attended workshops in a year (ELCE; n=21)	59%	28%	5%	8%
Attended workshops in a year (Others, n=27)	66%	20%	3%	11%
Attended educational conferences (all FEAS n=48)	46%	21%	25%	8%
Attended educ. conferences (ELCE; n=21)	49%	19%	24%	8%
Attended educ. conferences (Others, n=27)	46%	17%	26%	11%

Table 5: Instructional Development Activities: Seniority Differences

	None	One	Two	3 or More
Attended workshops in a year (all FEAS n=48)	61%	25%	6%	8%
Attended workshops in a year (< 5 years; n=13)	46%	39%	8%	7%
Attended workshops in a year (> 5 years, n=35)	66%	20%	3%	11%
Attended educational conferences (all FEAS n=48)	46%	21%	25%	8%
Attended educ. conferences (< 5 years; n=13)	46%	31%	23%	0%
Attended educ. conferences (> 5 years, n=35)	46%	17%	26%	11%

Table 6 summarizes responses to questions regarding the use of different teaching strategies, including the use of instructional technology. Chi-Square statistics were calculated for comparisons of Likert-scale responses between the junior and senior faculty. Where zero cell values occurred, the 4-point Likert scale was recoded as a 2-point scale. For clarity, only statistically significant (at least at 0.05 level, 2-tailed) results are shown. Table 6 shows instructors used mostly traditional teaching methods, relying on lecturing for the whole period of the class (90%) and on individual assessments (92%). Relatively few used non-traditional ones such self- or peer-assessments (33%), student presentations or group assignments (40%), or small group work in the class (25%). Instructional technology use was also very limited. While half of the respondents used email to communicate with students, the majority never or rarely used any instructional technology in the classroom.

Overwhelming reliance on lectures, individual homework and lack of use of alternative assessments were similar among ELCE instructors (the group with the highest survey return rate, 64%), and others in FEAS (91% vs. 89%, 95% vs. 89%, and 67% vs. 70%, respectively). This suggests Table 6 to be a representative picture of Engineering faculty at Ryerson University. ELCE respondents were less likely than others to use group home assignments (24% vs. 52%), in-class demonstrations (43% vs. 70%), small group work (19% vs. 30%), discuss their teaching with colleagues (52% vs. 78%), and use PowerPoint (9% vs. 33%) or multimedia (19% vs. 37%). However, this more conservative picture is almost certainly an artifact of a much higher return rate for ELCE, capturing better a cross-section of faculty. Instructors with interest in teaching are more likely to respond to educational surveys[24]. Thus, respondents from other departments within FEAS (18.9% return rate), are most likely biased toward those with such interest.

Table 6: Use of Different Instructional Methods and Technologies vs. Years of Experience; Frequencies in %

N-never; R-rarely U-usually; A-always →	FEAS (n =48)		< 5 years (n =13)		> 5 years (n =35)		Chi-Square Statistic
	N R	U A	N R	U A	N R	U A	
Lecturing for the whole period	10	90	15	85	8	92	
Distribute study guides	42	58	69	31	31	69	c^2 =9.151, df=3, p=0.027
Use of alternative assessments	69	31	92	8	60	40	c^2 =5.654, df=1, p=0.017
Use of student presentations	60	40	77	23	54	46	
Homework group assignments	60	40	62	38	60	40	
Homework individual assignments	8	92	23	77	3	97	
Use of design projects	42	58	69	31	31	69	c^2 =8.620, df=3, p=0.003
Examples leading to theory	48	52	54	46	46	54	
In-class demonstrations	42	58	62	38	34	66	c^2 =4.285, df=1, p=0.038
Connecting theory to lab	10	90	16	84	3	97	
Breakout small group work	75	25	69	31	77	23	
Ask feedback from students	23	77	31	69	20	80	c^2 =8.635, df=3, p=0.035
Discuss teaching with colleagues	33	67	24	76	37	63	
Transparencies	44	56	46	54	43	57	
Power Point	77	23	85	15	74	26	
WWW/multimedia	71	29	85	15	66	34	
Computer simulations	73	27	92	8	66	34	c^2 =4.081, df=1, p=0.043
Use of email	50	50	62	38	46	54	

Table 6 also shows that the already low uses of progressive instructional methods and of instructional technology were even lower among junior faculty. Junior instructors were significantly less likely to use alternative assessments, design projects, in-class demonstrations, solicit feedback from students, and use computer simulations. They were also less likely to use student presentations, connect theory to lab, use PowerPoint, multimedia and email to communicate with students, but these differences were not statistically significant. Fewer junior faculty members relied on individual homework assignments for student assessment than their senior colleagues did. However, since both groups were equally less likely to use group homework for evaluations, that may simply indicate less reliance on homework assignments in general, than an emphasis on collaborative assignments. Table 7 shows the summary of views on the teaching and learning process on a continuum from behaviourist, through cognitive to constructivist elements[13]. Even though these terms were not explicitly used, a significant proportion of respondents (17%) indicated not understanding some or all of the descriptors used in this portion of the survey. This suggested lack of familiarity with educational jargon. Thus, the responses were most likely skewed toward the "middle of the road", safe responses and the overall teaching and learning philosophy is most likely more conservative than the scores in Table 7 indicate. Nevertheless, the average score of 12.3, somewhere between behaviourist (less than 10) and cognitive (between 10 and 16) models[13], is still consistent with the assertion of the prevailing instructivist, traditional teaching model.

Table 7: Faculty Survey: Views on Teaching-Learning Process

	Behaviourist views	**Cognitivist views**	**Constructivist views**	**Don't Know**
Role of teacher	29%	64%	4%	3%
Role of learner	27%	47%	19%	7%
Learner differences	4%	65%	27%	4%
Learning process	18%	66%	4%	11%
Instructional approach	31%	50%	12%	7%
Role of context	4%	40%	47%	9%
Overall Paradigm	33%	54%	12%	

Self-reported low participation in professional development activities (Table 5), low use of student-centred activities and of instructional technology (Table 6) and low pedagogical knowledge among engineering faculty (Table 7) are consistent with the DMP data and with other studies[25, 26, 27, 28]. This supports *construct validity* of the survey, i.e. whether it adequately reflects what it is supposed to measure[15, 29]. While the overall use of innovative teaching and of instructional technology was low, there was a significant correlation between the two, as shown in Table 8. This is consistent with the reports that the use of instructional technology is associated with progressive educational models[11, 30, 31, 32], providing further support for construct validity.

Each semester, the University conducts institution-wide Instructor-Course Evaluations (ICE) - student surveys consisting of 11 multiple choice questions regarding course content and quality of teaching, including a "global" question on the instructor effectiveness. It uses a 4-point Likert scale for the response, with 5 being the worst and 1 being the best. A self-declared ICE score on the "global" question was one of the demographic items on the instructor survey. No correlation was found between the ICE score and the use of student-centered strategies. Among those using instructional technology, there was a weak negative correlation between the levels of use and the ICE score, but not statistically significant. Lack of correlation is most likely a result of a small sample size (n=16). No correlation was found between the ICE score and their participation in professional development. Neither was any correlation found between the ICE score and faculty learning styles, nor between the use of instructional methods and learning style modalities, except for the Active scale. Low but statistically significant or nearly significant correlation was found between that scale and the use of small group work in class ($r=0.291$, $p=0.045$), design projects ($r=0.294$, $p=0.043$), use of demos ($r=0.268$, $p=0.065$), and home group assignments ($r=0.267$, $p=0.067$). There was moderate and significant correlation between Active modality and the use of multimedia ($r=0.350$, $p=0.015$) and email ($r=0.325$, $p=0.024$).

Table 8: Pearson's Correlation between the Use of Instructional Technology and Student-Centred Instructional Methods (n=48)

	Multi/ WWW	Comp. Simul.	Power Point	Asynch Tools	Demos	Small Group Work	Home Group Assign.	Design Project	Peer- & Self Eval.	Presentations
Multi/ WWW	1.000 .	0.580** p=0.000	0.487** p=0.000	0.400** p=0.000	0.400** p=0.005	0.266 p=0.067	0.547** p=0.000	0.498** p=0.000	0.300* p=0.038	0.460** p=0.001
Comp Sim.		1.000 .	0.335* p=0.020	0.432** p=0.002	0.263 p=0.071	-0.025 p=0.869	0.366** p=0.010	0.280 p=0.054	0.359* p=0.012	0.214 p=0.144
PPoint			1.000 .	0.275 0.059	0.489** p=0.000	0.344* p=0.017	0.142 p=0.337	0.287* p=0.048	0.485** p=0.000	0.370** p=0.010
Asynch Tools				1.000 .	0.226 p=0.122	0.213 p=0.145	0.267 p=0.066	0.292* p=0.044	0.327* p=0.023	0.094 p=0.525
Demos					1.000 .	0.465** p=0.001	0.280 p=0.054	0.321* p=0.026	0.265 p=0.068	0.459** p=0.001
Small Gr. Wk.						1.000 .	0.467** p=0.001	0.290* p=0.045	0.271 p=0.062	0.482** p=0.001
Home Gr. Assign.							1.000 .	0.564** p=0.000	0.185 p=0.207	0.636** p=0.000
Design Project								1.000 .	0.185 p=0.207	0.636** p=0.000
Peer- & Self Ev.									1.000 .	0.441** p=0.002
Presentations										1.000 .

** Statistically significant at 0.01 level, 2-tailed; * Statistically significant at 0.05 level, 2-tailed.

Most surprisingly, there was a moderate, significant and negative correlation between the Visual modality and the use of computer simulations (r=-0.553**, p=0.0005) and multimedia (r=-0.283, p=0.052). There was also a correlation between years of experience and connecting the lab to theory (r=0.308, p=0.033), assessments based on individual work (r=0.322, p=0.026), responsiveness to student questions (r=0.467, p=0.001), and the use of humor (r=0.352*, p=0.014). Table 9 shows a significant correlation between the use of innovative strategies and views on instructional approach, and an overall view on the teaching and learning process as a continuum from a behaviorist to constructivist model[13], also supporting construct validity.

Table 9: Pearson Correlation between the Use of Student-Centred Instructional Methods and Views on Learning & Teaching (n=48)

	Publish Objecti.	Format Feedb.	Peer- & Self Ev.	Inductiv Teach.	Big Picture	Small Gr. Wk.	HomGr. Assign.	Design Project	Demos	Presentations
Valcke Score	0.359** p=0.012	0.378** p=0.008	0.332* p=0.021	0.352* p=0.014	0.301* p=0.037	0.245 p=0.093	0.118 p=0.423	0.109 p=0.462	0.045 p=0.760	0.189 p=0.198
View on Instr	0.213 p=0.161	0.178 p=0.243	0.097 p=0.525	0.199 p=0.190	0.072 p=0.637	0.509** p=0.000	0.493** p=0.001	0.398** p=0.007	0.364* p=0.014	0.415** p=0.005

** Statistically significant at 0.01 level, 2-tailed; * Statistically significant at 0.05 level, 2-tailed.

Respondents to educational surveys often have better teaching evaluations than institutional norms[24]. This was also the case in the study. The 2002 mean values for the "global" question in the ICE survey on the instructor effectiveness were released as 1.90 for both FEAS and ELCE. At 1.77, the average self-declared ICE score (n =38) was better. This suggests that the 72.7% of

FEAS faculty members, who did not respond to the survey, have on average worse teaching evaluations than those 27.3% who did. Thus the picture painted by the survey results is possibly even more conservative. The low return rate (only 14%) among the junior faculty likely indicates lower interest in educational issues. As they constituted proportionally the largest segment of those who did not respond to the survey, worse teaching practice among the younger faculty is also likely, and of much concern. Among respondents, the self-declared ICE score was weakly negatively correlated with years of experience, with the average score for junior faculty of 2.06, compared with 1.66 for those with more than 5 years of experience (ANOVA $F=2.911$, $df=1,36$, $p=0.097$). Although these results lacked statistical significance, most likely because of the small sample size, they support the conclusion regarding the generally worse teaching practice among younger faculty.

IV. Conclusions

Survey Summary

Intuitive and Reflective preferences found among the engineering faculty are a match for conventional teaching methods, relying on theory and providing little encouragement for student interactions and feedback. These methods however do not support the needs of the students, who are predominantly Active and Sensing learners. The survey showed instructional strategies that incorporated few principles of active, collaborative, student-centered learning (see Table 6 and Table 7). And, while most faculty themselves had strong visual learning preferences, the survey also showed low rates of the use of instructional technology, of computer simulations, and an over-reliance on Verbal lecturing style. The low priority assigned to student-centered strategies was consistent with the national survey[13] results, indicating the use of web-based technologies primarily in support of information transfer (82%), rather than student participation (5%) or interactivity (3%).

This discrepancy underscores the need for development of teaching skills among the faculty. Unlike the learning *style*, which is considered an individual characteristic that does not change significantly faculties[33, 34], teaching and learning *strategies* can be modified[4,6, 35]. However, such modifications require self-awareness, reflection, effort, and training. Yet reported levels of attendance at educational conferences and workshops were low, with young faculty members less likely to participate. Paradoxically, despite proliferation of technology for research and personal use, younger faculty members were less likely to use instructional technology in teaching. They also responded to the survey at a significantly lower rate than their more experienced peers did, which suggests low interest and low priority assigned to educational issues.

Canadian Context for the Faculty Survey

A countrywide context helps in proper interpretation of the survey results. Such context is provided here by the results of a McGraw Hill survey on faculty perceptions regarding technology and student success, which has been conducted annually among Canadian faculty since 1999. The latest survey[13] was emailed in December 2002 to approximately 20,000 faculty in Canada, and had n=1177 respondents, 49% of whom represented universities. Demographics data (regional representation, gender, seniority, position, type of department) of the survey was well matched with the data from the Association of Universities and Colleges of Canada (AUCC), providing a good snapshot of the faculty attitudes and practices vis-à-vis implementation of educational technology.

The respondents overwhelmingly taught face-to-face courses (95%), as compared to online distance learning (11%). Of on-campus courses, 18% are hybrid, or blended courses, combining face-to-face contact with online support. Of those that used technology in teaching (n=631), 82% used it to distribute information (syllabus, lecture notes, etc.). Of those that created course materials (n=465), 47% described them as lecture notes, 41% as assignments and projects and 21% as course outlines and objectives. In general, technology was seen as helping to achieve teaching objectives that could be described as instructor centered: keeping up-to-date (27%), finding supplementary information (27%), and distributing content to students (13%). Student-centered objectives had lower priority: encouraging student participation (5%), providing real-life examples (5%), two way communications (4%), interactive activities (3%), online grades (3%). And, while 58% of respondents identified the need to promote critical thinking as the teaching objective, only 1% saw the web-based technology as the means to promote it.

Asked about the likelihood of using specific tools to optimize learning outcomes, the following tools were chosen: textbooks (79%), presentation technology (66%), relevant web links (44%), interactive exercises (19%), web learning objects (16%), simulations (14%), animations (8%), online quizzes (7%). Approximately 10% (n=185) of respondents declared the use of learning objects, but of those, 14% did not know what the learning object was, and many considered web links (43%), lecture notes (22%) and assignments (19%) to be the learning objects. Only 1.5% respondents identified interactive components as the learning objects, and declared their use. Lack of technological "know-how" was not seen as a major barrier to integration of technology. Over 30% of respondents considered themselves as technologically self-sufficient, and over 50% as committed to the use of new technologies in teaching. The two most frequently mentioned barriers were, knowing what is available (50%) and lack of development time (49%).

In summary, web technology was seen mainly as the broadcast medium, rather than an enabler of student engagement, collaboration and critical thinking. Changing this perception may prove to be the most difficult impediment to effective integration of technology in teaching. The survey results show the prevalence of instructor-centered philosophy, and relatively low importance of educational professional development to the surveyed faculty.

Conclusions and Recommendations

The results of the national survey underscore the fact that the trends observed by the author are not specific to one particular institution, but rather are symptomatic of wider concerns. The scholarship of teaching is systemically undervalued across the higher education, even more so within the culture of engineering faculties[11, 12, 9]. Academic reward systems and hiring policies are generally not conducive to scholarship of teaching, emphasizing research. Younger faculty members thus attach less significance to teaching[10]. They rarely acquire any training to prepare them for it, and few have spent time as practicing engineers. After hiring, they come under pressures of tenure process, struggle to secure research grants, publish, and supervise graduate students. This leaves little time or incentive to work on improving their teaching, attending educational workshops, or even filling out educational surveys. Professional development of engineering faculty becomes more urgent as accumulated applied engineering and teaching experience is being lost through impending retirements. Ironically, with faculty renewal, there is a risk of the dominant culture becoming even less responsive to students' needs. Such concerns have been highlighted before and this study confirms them.

There is reason to believe that the U.S. educational system is responding to the challenge. Pressures from Engineering Criteria 2000 and NSF-initiated Engineering Education Coalitions programs are having an impact on curricula and faculty development[10, 36, 37]. There is also a growing understanding that the societal attitudes about engineering need to change as well. At the 2001 Deans' Summit on Education for a Technological World in Baltimore, MD, much of the discussion concentrated on fostering collaborations and community outreach that would excite the public about engineering, and on issues of improving the teaching of it by using education methods and research developed in education schools[38]. Positive examples of system-wide changes and innovative programs also exist in Australia[39] and the U.K.[28, 40, 41].

However, similar efforts in Canada are still rare. Over the next ten years, a demographic surge combined with the task of faculty renewal, and ever-increasing pace of change in the workplace will put unprecedented pressures on the Canadian university system. Redefining academic teaching, and issues of technology integration transcend engineering education. The questions of teaching in higher education and of educational professional development, including instructional technology use, need to be put on the Canadian national educational agenda. Some of the efforts to do so include the web-based faculty support initiative initiative (http://www.facultydevelopment.ca/) spearheaded by the 3M Teaching Fellows, the Society for Teaching and Learning in Higher Education (STLHE), Instructional Development Offices (IDO) from across Canada, and McGraw-Hill Ryerson, and a meeting of the Think-Tank of 3M Teaching Fellows scheduled for May 2003.

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