STUDENT LEARNING STYLES AND THEIR IMPLICATIONS FOR TEACHING

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This Occasional Paper will make the case that all faculty members, no matter the discipline, can put an understanding of learning styles to good use in their own teaching. In this regard, we use ourselves as cases in point. Montgomery is responsible for a major introductory lecture course in chemical engineering and has incorporated a variety of active learning strategies to accommodate a diversity of student learning styles. Groat's interest in learning styles derives from her research on pedagogical practices that inhibit or promote the inclusion of women and minority students in architectural education, particularly in one-to-one teaching settings such as the studio.

Neither of us is an 'expert' in learning styles research, and we acknowledge that psychologists do not uniformly endorse many popular conceptualizations of learning styles. Nevertheless, in our interactions with faculty and students and in our knowledge of the literature, we know that the notion of learning styles resonates among faculty and students. Therefore, this topic merits further consideration. Although we approach learning styles from different disciplines and teaching experiences, we have both discovered that an understanding of learning styles is fundamental to our individual approaches to teaching. We believe it can have an impact on the teaching approaches of all faculty.

Why Incorporate Learning Styles in our Teaching?

We believe there are many reasons to incorporate an understanding of learning styles in our teaching. Here are some starting points for consideration.

1. Making Teaching and Learning a Dialogue. Whether we are aware of it or not, an assumption underlying many of our current teaching practices is that students are "empty vessels," and our role is to fill them with knowledge. But increasingly, research on student learning suggests that the metaphor of "dialogue" is more appropriate in that it emphasizes "the interactive, cooperative, relational aspects of teaching and learning" (Tiberius, 1986, p. 148). Once faculty shift from the "empty vessel" model to a dialogic and communal one, old habits in teaching begin to shift. A lecture class no longer entails simply a scripted delivery of information (no matter how well done), but it may also include a variety of "active learning" techniques that truly engage students in the collective dialogue.

2. Responding to a More Diverse Student Body. By now it is axiomatic to point out that student bodies are increasingly diverse, not only in terms of ethnicity and gender, but also in terms of age, nationality, cultural background, etc. This diversity can affect classroom settings in many ways, including the diversi-

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ty of learning styles. For example, older students who can draw from their life experience are more likely to be independent, "self-directed" learners (Knowles, 1980). And thanks to the work by Belenky et al. (1986), there is considerable evidence to suggest that many women tend to approach learning in more "connected" ways, meaning a style that emphasizes empathy, collaboration, and careful listening. Meanwhile other research suggests that African-American and Mexican-American students are more likely to prefer working with others to achieve common goals (Banks, 1988). Despite these apparent tendencies, it is equally important not to pigeonhole students on the basis of expected learning styles since a vast range of individual differences is evident within any demographic group.

3. Communicating Our Message. As faculty, we tend to be passionately committed to our discipline/profession and are anxious to convey its significance and knowledge base to our students. Despite our good intentions, we may be so concerned with covering the subject matter that we lose track of how much of that material really gets conveyed through our taken-for-granted teaching modes. For example, in a typical 50-minute lecture class, students retain 70% of what is conveyed in the first 10 minutes but only 20% from the last 10 minutes (McKeachie, 1994, p. 56). If we really want to get our message across, we need to orchestrate "the material" in a multi-faceted way across the range of student learning styles.

4. Making Teaching More Rewarding. If we are not inclined to much self-reflection about our teaching practices, we are likely to continue to teach others the way we learn best, assuming that this way will work for all students. But given the increasing diversity of the student body, as well as the higher expectations for teaching performance among university administrators, it's likely that many of us are feeling a bit uneasy about teaching the way we always have; it may simply feel a bit less 'right,' a little less rewarding. In the area of research, faculty take great pride from launching substantive innovations in their fields. It is our contention that by making an effort to consider student learning styles, we may be able to reap equal satisfaction from reinvigorating our teaching practices.

5. Ensuring the Future of Our Disciplines. An undisputed assumption in career counseling is that any individual will be better suited to some tasks, subject areas, and careers than others, as a function of personality, talents, cognitive styles, and so on. On the other hand, not all the habits and conventions of a given discipline/profession are inherent in even the most essential aspects of a given field. More important, now that we are obliged to confront massive changes in nearly every field, some of the established traditions of teaching and learning a given field may be counter-productive. Over 15 years ago, educational theorist David Kolb observed, "Over time... selection and socialization pressures combine to produce an increasingly impermeable and homogenous disciplinary culture and correspondingly specialized student orientations to learning" (Kolb, 1981, p. 234). In the end, we may be ensuring the long-term viability of our given field if we make sure that students with a diversity of learning styles are welcomed and encouraged.

LEARNING STYLE MODELS

In this Occasional Paper we summarize four models prevalent in discussions of learning styles, and we offer a range of strategies for making our teaching sensitive to the important issues they raise.

MYERS-BRIGGS TYPE INDICATOR™

Description. Perhaps the most well-known instrument for identifying personality types is the Myers-Briggs Type Indicator™. Developed by Isabel Briggs Myers and Katherine Cooks Briggs, the inventory is based on Carl Jung's concept of archetypes (McCaulley et al., 1983; Myers & McCaulley, 1986). An individual's personality profile is identified along four dimensions: orientation to life (Extroverted/Introverted); perception (Sensing/iNtuitive); decision making (Thinking/Feeling); and attitude to the outside world (Judgement/Perception). People can thus be said to belong to one of sixteen categories, based on their preferences along each of these dimensions. An introverted, sensing, feeling, and judging person would thus be categorized as having an ISFJ personality. Examples of the characteristics of each of these personality dimensions are shown in Table 1.

The Myers-Briggs Type Indicator™ has been widely used to classify student learning styles in various disciplines (McCaulley, et al., 1983; Schroeder, 1993). The first two dimensions (Orientation and Perception) appear to have implications for learning (Schroeder, 1993). Unfortunately, the predominant learning styles of college students contrast sharply with the predominant styles of university faculty, as described in Table 2. About two-thirds of faculty are intuitive, and over half are introverted (Grasha, 1996). While instructors as a whole prefer to focus on abstractions, the majority of students prefer to start with practical applications and examples, building to abstract theories.

Another potential area of mismatch relates to the Thinking/Feeling dimension, the only dimension which demonstrates a consistent gender difference. About two-thirds of women have profiles in which feeling predominates, while two-thirds of men have profiles in which thinking predominates (Kroeger & Thuesen, 1988). (As many researchers have argued, women's tendency to emphasize humane values and an ethic of caring may well be significantly influenced by the social construction of gender. This is indeed a valid point of discussion, but outside the scope of this Occasional Paper.) This could pose problems for students in particular gender-dominated disciplines. For example, women students taking courses in male-dominated fields are more likely to find a logical, objective emphasis alienating; and similarly male students taking courses in other disciplines may be more likely to object to what they see as an over-emphasis on subjective interpretations and personal relationships.

Implications for Teaching. Realistically, no faculty member can

ORIENTATION TO LIFE	Extroverted Group interactions Applications	Introverted Working alone Concepts and ideas
PERCEPTION	Sensing Facts and data Routine	iNtuitive Impressions Not routine
DECISION MAKING	Thinking Objective Logical	Feeling Subjective Search for harmony
ATTITUDE TO OUTSIDE WORLD	Judgement Planning Control	Perception Spontaneity Adaptive

Table 1. Preferences of Myers-Briggs Personality Types

expect to develop different ways of teaching for each individual student. Rather, as faculty we should strive to provide a variety of learning experiences, such that at one point or another each learning style is addressed. For example, in a heavily abstract course, faculty should include some applications that will help the sensing student understand the reason for learning the abstract concepts. Other activities that are particularly engaging for sensing learners include case studies, group projects, and in-class presentations. We should expect students to solve not only rote problems but also more open-ended problems, thus challenging both sensing and intuitive learners. We should include a combination of individual and group work, not relying solely on either mode, to satisfy both extroverts and introverts.

Kolb/McCarthy Learning Cycle

Description. A significant impetus in the development of the Kolb/McCarthy learning cycle model was Kolb's observation of the distress encountered by many students whose learning styles seemed mismatched to their disciplinary majors (Kolb, 1981).

	Faculty	Students
Extroverted	46%	70%
Introverted	54%	30%
Sensing	36%	70%
Intuitive	64%	30%

Table 2. Preferences Patterns of Faculty and Students

An underlying assumption of the model is that all learning entails a cycle of four learning modes, but each individual is likely to feel most comfortable in one of the four modes of the cycle based on her/his preference along two dimensions: Perception and Processing (Kolb, 1984, 1995; Harb et al., 1995). Perception (Abstract/Concrete) has been found to correlate with the Decision-Making (Feeling/Thinking) mode of the Myers-Briggs model (Kolb, 1984). Processing (Active/ Reflective) encompasses primarily the Orientation (Extrovert/Introvert) mode of the Myers-Briggs model (Kolb, 1984). Together, Perception and Processing reflect the major directions of cognitive development derived from the work of Piaget (1970).

The four learning styles in the Kolb model are also distinguished by the type of question that concerns each category: "Why?" "What?" "How?" and "What if?" Likewise, each academic field can be mapped against this same set of dichotomous dimensions according to what type of learning mode predominates in that discipline. Thus, according to this model, the concrete/reflective quadrant encompasses social science and humanities; the abstract/reflective quadrant reflects the physical sciences; the abstract/active incorporates science-based professions such as engineering; and finally, the concrete/active domain reflects the more social professions such as education. Figure 1 illustrates the learning styles and learning cycle based on Kolb's model.

There is also some evidence that male and female students are differentially attuned to the four different learning styles identified by this model. Researchers have found that in a sample of adults (across a wide range in age and ethnicity), nearly half of the male respondents (48%) preferred the assimilator (abstract/reflective) mode, whereas only 20% of the women did (Philbin et al, 1995). Not only were the women's responses more evenly distributed across the four styles, the women's predominant modes were diverger (concrete/reflective) and converger

(abstract/active). Using the analysis provided in Figure 2, this would mean that many women students are more likely to respond to faculty who adopt either the motivator or coach stance; whereas male students are more likely to feel comfortable with faculty who adopt the role of expert.

Implications for Teaching. The fact that students majoring in a given discipline are more likely to have particular learning style characteristics common to faculty and practitioners in that field may seem entirely consistent with common sense notions of expert competence. On the other hand, Kolb has pointed out that selection and socialization processes may lead to such a homogenous disciplinary culture that it becomes impermeable to other influences. Equally disturbing, one aspect of Kolb's research demonstrated that over time science students become more analytical and *less* creative, while arts students become more creative and *less* analytical. In other words, the educational process has the potential to accentuate the gap in capabilities between these groups of students.

Suggested activities and faculty roles corresponding to each of these learning styles are shown in Figure 2. Again, one need not try to do it all, but checking one's course plans against the suggested activities in Figure 2 could spawn ideas for supplemental activities to provide a more complete educational experience. The Kolb model suggests following a "Learning Cycle" that addresses these questions in order. By "teaching through the (Kolb Learning) cycle" one can ensure that all learning styles have been addressed, in that all questions have been answered. The questions include the following: "Why are we learning this?" "What are the key points of this issue?" "How do I use this knowledge?" and "What are the implications of this information in other contexts?"

Felder-Silverman Learning Styles Model

Description. The learning styles model developed by Richard Felder and Linda Silverman (Felder, 1993; Felder and Silverman, 1988) incorporates five dimensions, two of which replicate aspects of the Myers-Briggs and Kolb models. To be specific, the Perception dimension (sensing/intuitive) is analogous to the Perception of both Myers-Briggs and Kolb; the Processing dimension (active/reflective) is also found in Kolb's model. In addition, Felder-Silverman posit three additional dimensions: Input (visual/verbal), Organization (inductive/deductive), and Understanding (sequential/global). Table 3 summarizes the five learning style dimensions. Soloman's Inventory of Learning Styles (Soloman, 1992) can be used to assess four of the five learning style preferences in the Felder-Silverman classification scheme. For clarity, an overall comparison of the dimensions in the Myers-Briggs, Kolb, and Felder-Silverman models is presented in Table 4.

In our own teaching, we have each had occasion to use the Felder-Silverman model and the associated inventory questionnaire developed by Soloman. Data we've compiled from students in our classes in chemical engineering and architecture lend support to Kolb's contention that variations in disciplinary culture can be analyzed through learning styles models. Based on the comparative data, it appears that the engineers are more active, sensing, verbal and sequential than the architects. Moreover, when the data from the architecture students were analyzed in relation to level in the program, there was an obvious tendency for advanced students to be relatively more reflective, visual, and global than beginning students; and the percentage of intuitives at all levels of the program is far higher than in the general population of college students. Moreover, the advanced students were more likely than

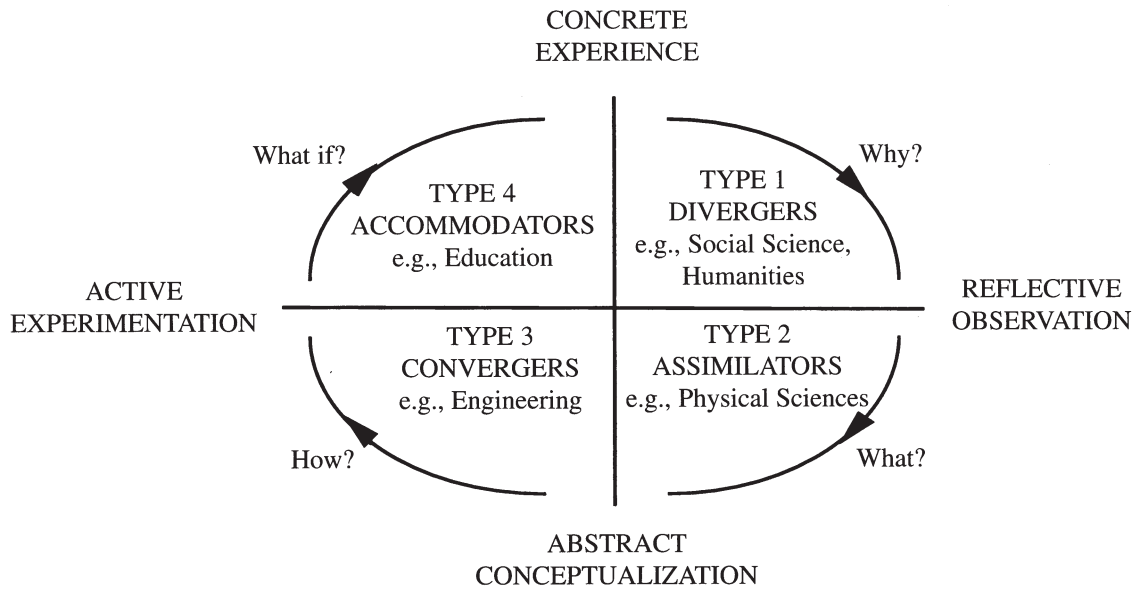

Figure 1. Learning Styles and Learning Cycle Based on Kolb's Model

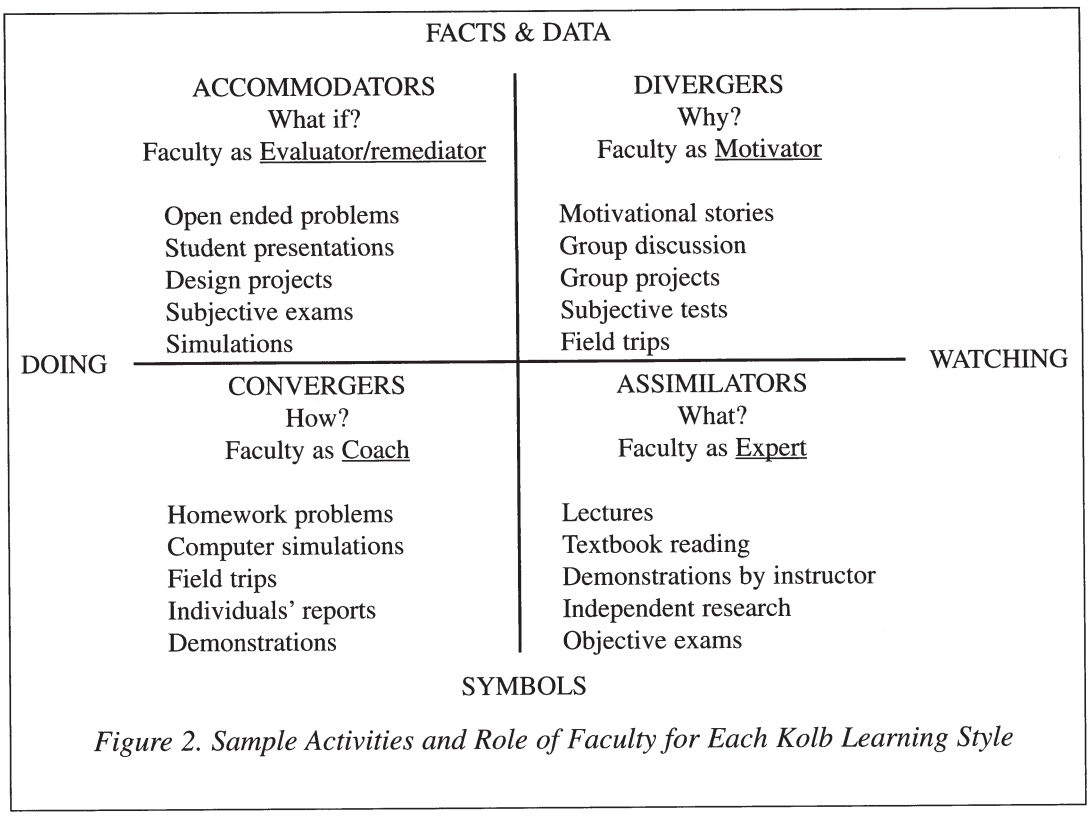

Figure 2. Sample Activities and Role of Faculty for Each Kolb Learning Style

GRASHA-RIECHMANN LEARNING STYLES

Description. The learning styles typology developed by Anthony Grasha and Sheryl Hruska-Riechmann is distinct from the other three models in that it is based on students' responses to actual classroom activities rather than on a more general assessment of personality or cognitive traits. Grasha argues that this situation-specific approach is more likely to be reliable and valid. Using a personality type approach requires the researcher to extrapolate the results to classroom settings; whereas the Grasha-Riechmann typology is designed to help faculty identify teaching techniques that address particular learning styles.

the novice students to have learning style profiles similar to studio faculty. In engineering, graduate students and faculty are more intuitive, inductive and reflective than engineering undergraduate students (Felder and Silverman, 1988).

Data from both architecture and engineering are also consistent with observations of gender differences in the research studies already cited (e.g., Belenky et al., 1986; Philbin et al., 1995). Montgomery found that women engineering students were more geared to an active learning mode than their male counterparts by a margin of 7% (72% to 65%); and Groat found that women architecture students showed a similar tendency by a margin of 17% (67% to 50%).

Implications for Teaching. Given the contemporary belief that organizations increasingly require people who can work effectively in multidisciplinary teams and integrate concepts across disciplinary knowledge bases (e.g. Reich, 1993), faculty should be teaching to a sufficient diversity of student learning styles to encourage innovation in their fields. In this regard and in concert with other researchers, Felder advocates a balance between the extremes in each learning dimension. Suggestions one could incorporate into courses include: providing a context for the concepts addressed, such as connections with relevant material from students' everyday experiences (global); balancing theory and models (intuitive) with demonstrations and examples (sensing); using pictures, sketches, and diagrams (visual) to supplement verbal information; using numerical as well as algebraic examples (sensing, inductive) to illustrate abstract concepts (intuitive, deductive); and providing time for both student participation (active) and reflection on the material presented (reflective).

Table 5 describes the characteristics of each style along with corresponding preferences in classroom environment. Another distinguishing aspect of the Grasha-Riechmann typology is that it does *not* assume the bipolarity of the scales. Among the six styles of learning, only the Participant/Avoidant types represent a clear dichotomy that is supported by statistical analysis. Grasha originally hypothesized the other four styles as dichotomous, in the following way: Competitive/Collaborative and Dependent/Independent. But the dichotomy of these styles was not borne out. Over the years, Grasha and other researchers have investigated the correlation of this learning style typology to other demographic characteristics. In contrast to Kolb's findings, Grasha has not found any consistent relationship between academic major and his learning style typology. On the other hand, his research has demonstrated some consistent variations due to gender, student age, and grade (Grasha, 1996). More specifically, women students typically have higher scores on the collaborative style; students over 25 tend to employ more independent and participatory styles; and students with a participatory style get higher grades than those with avoidant styles. Groat's pilot study with architecture students, using an abbreviated form of the Grasha-Riechmann questionnaire, is consistent with the nature of Grasha's findings: Women architecture students evidenced substantially higher collaborative and participatory scores, while they also scored substantially lower on the competitive scale. Also consistent with Grasha's findings, older architecture students scored substantially higher on the independent scale.

Groat's pilot study also offers some suggestive, program-specific trends with regard to ethnic differences. Her data suggest that

Dimension	Range	
PERCEPTION	Sensing Data obtained via senses	Intuitive Symbols
	Facts and observations	Interpretations
INPUT	Visual Charts and pictures	Verbal Spoken word
ORGANIZATION	Inductive Facts and observations	Deductive General principles
PROCESSING	Active Doing something	Reflective Introspective processing
	Group work	Independent work
UNDERSTANDING	Sequential Linear connections	Global Holistic connections
	Small connected chunks	"Big picture"

Table 3. Felder-Silverman Learning Style Dimensions

both African-American and Asian-American architecture students evidenced higher scores on the dependent scale (and lower independent scale scores) than either Caucasian or Hispanic students. Other data from a separate survey of architecture program students found that African-American and Asian-American students were the least satisfied with their academic program. This pattern seems consistent with Randall et al.'s observation that "students tend to behave more independently when they are confident of their ability to perform" (1995, p. 73). Thus, the learning styles analysis has contributed to identifying some potential problem areas in the academic program and could be followed up with more detailed focus interviews with relevant student groups.

The other distinguishing characteristic of Grasha's approach to learning styles is that he has also developed a corresponding typology of teaching styles, similarly based on actual classroom behaviors. The result is that learning and teaching styles can be mapped together to more fully describe the social dynamics of the classroom setting. Table 6 summarizes four basic clusters of compatible learning and teaching styles.

Implications for Teaching. Grasha does not advocate attempting to accommodate all learning style preferences at all times, but he shows that an awareness of these styles can help faculty augment their methods of presentation. For example, one might add to an originally lecture-centered course some opportunities for small group discussions to engage the collaborative learner; introduce open-ended questions to typical close-ended assignments to engage the independent learner; and provide direction early in the semester for the dependent learner. Grasha encourages faculty to assist students in developing the learning styles they are weak in by easing them into the corresponding type of activity. For example, one might choose to provide less and less direction as the semester progresses, enabling dependent learners to become more independent.

CONCLUSIONS

Inevitably, students bring to the classroom a great diversity of learning styles. As Grasha (1996) argues, the problem is not that faculty/student mismatches sometimes occur, but rather it is the failure to acknowledge and work out the potential conflicts and

MODE	RANGE	Myers-Briggs	Kolb	Felder-Silverman
ORIENTATION TO LIFE	Extrovert—Introvert	X		
PROCESSING	Active—Reflective		X	X
PERCEPTION	Concrete—Abstract		X	
DECISION MAKING	Feeling—Thinking	X		
PERCEPTION	Sensing—Intuitive	X		X
ATTITUDE TO OUTSIDE WORLD	Judging—Perceiving	X		
INPUT	Visual—Verbal			X
ORGANIZATION	Inductive—Deductive			X
UNDERSTANDING	Sequential—Global			X

Table 4. Comparison of Learning Style Models

Style	Characteristics	Classroom preferences
Competitive	Compete with other students	Teacher-centered, class activities
Collaborative	Share ideas with others	Student-led small groups
Avoidant	Uninterested, non-participant	Anonymous environment
Participant	Eager to participate	Lectures with discussion
Dependent	Seek authority figure	Clear instructions, little ambiguity
Independent	Think for themselves	Independent study and projects

Table 5. Characteristics of Grasha-Riechmann Learning Styles

misunderstandings that undermine student learning. Indeed, acknowledgment can be empowering for students if they can be made aware of their preferred learning style(s) and assisted in stretching their capabilities to accommodate greater variety (Randall et al., 1995).

What can faculty do? First, faculty should begin by being self-reflective about their pedagogical goals and strengths in teaching. As Grasha suggests, any attempt to modify one's teaching style needs to be framed within this broader conceptual context. Second, it is important to remember that neither learning nor teaching styles are immutable; they can be modified over time and for different purposes in different classroom contexts. So while it may be advantageous to modify one's teaching style to fit a broader range of students in a particular class, it may also be of benefit to those same students to gradually introduce class activities that substantially expand their learning style preferences.

Moreover, matching teaching style to learning style is not a panacea that solves all classroom conflicts. Other factors such as classroom climate, previous background, motivation, gender and multicultural issues will of course greatly influence the amount and quality of learning that takes place, as McKeachie (1995) reminds us. Still, for faculty members, being self-reflective and explicit about the role of learning styles can make teaching more rewarding and enhance student learning at the same time.

Cluster 1	**Cluster 2**
Primary Learning Styles Dependent /Participant/Competitive	*Primary Learning Styles* Participant/Dependent/Competitive
Primary Teaching Styles Expert/Formal Authority •Exams/Grades Emphasized •Lectures •Mini-Lectures + Triggers •Teacher-Centered Questioning •Term Papers •Technology-Based Presentation	*Primary Teaching Styles* Personal Model/Expert/Formal Authority •Role Modeling by Illustration -Sharing Thought Processes -Sharing Personal Experiences •Role Modeling by Direct Example -Demonstrating Ways of Doing •Teacher/Coaching/Guiding Students
Cluster 3 *Primary Learning Styles* Collaborative/Participant/Independent	**Cluster 4** *Primary Learning Styles* Independent/Collaborative/Participant
Primary Teaching Styles Facilitator/Personal Model/Expert •Case Studies •Guided Readings •Key Statement Discussions •Laboratory Projects •Problem Based Learning -Group Inquiry -Guided Design -Problem Based Tutorials •Role Plays/Simulations •Roundtable Discussion	Primary Teaching Styles Delegator/Facilitator/Expert •Helping Trios •Independent Study/Research •Jigsaw Groups •Learning Pairs •Practicum •Small Group Work Teams •Student Journals

Table 6. Teaching Methods Associated With Each Cluster of Teaching and Learning Styles

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