OPINION: USES, MISUSES, AND VALIDITY OF LEARNING STYLES*

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ABSTRACT

In the past four decades, learning styles have progressed from being an interest of a few academics to a concept that has been applied by countless teachers and researchers at all levels of education. At the same time, several educational and cognitive psychologists have argued vehemently against taking learning styles into account when designing instruction, basing their arguments almost entirely on a lack of demonstrated validity of the "meshing hypothesis," which asserts that matching instruction to students' individual learning style preferences maximizes the students' learning. This paper describes and reviews the origins of a learning style model that has been applied extensively in engineering education and an online instrument that has been accessed by millions of users to assess students' preferences for different approaches to instruction defined by that model. The paper goes on to show that the challenges to learning styles are mostly fallacious, since they are based on statements (including the meshing hypothesis) the challengers attribute to learning style proponents which most proponents reject. The point of learning styles is not to match instruction to individual students' learning style preferences, but rather to teach in a manner that balances the preferences of students with different learning styles. Strategies suggested for attaining such a balance are fully compatible with both cognitive science and empirical educational research.

Key words: Learning styles, teaching skills, diversity

INTRODUCTION

In 1988, educational psychologist Linda Silverman and I coauthored an article entitled "Learning and Teaching Styles in Engineering Education" that defined a model of student preferences for specified modes of teaching (Felder and Silverman 1988). The concept of learning styles had been around for several decades, and by 1988 there were several dozen published models in the literature. Dr. Silverman and I drew preferences from several of those models that we felt would be particularly applicable to engineering education. With Barbara Soloman I later co-developed and validated an online questionnaire called the *Index of Learning Styles*® (ILS) (Felder and Soloman n.d.) that assessed students' preferences on the scales defined in the 1988 paper, an instrument that would eventually be accessed by millions of users. In 1997 I was invited to trace the history of my involvement with learning styles and the origins of the ILS. The present paper began as an updated version of my response to that invitation, which appeared in the *Proceedings of the 1998 Annual ASEE Conference*.

Since 1998, interest in learning styles at all levels of education has skyrocketed. A recent Google Search for "Index of Learning Styles" yielded roughly 200,000 hits, including validation

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studies (such as Felder and Spurlin 2005; Felkel and Gosky n.d.; Litzinger et al. 2007; Zywno 2003), research studies that made use of the instrument, and testaments by instructors on the instrument's positive impact on the quality of their teaching and on their students' awareness of their own learning strengths and potential areas for improvement.

As educators were becoming increasingly interested in the concept of learning styles, some academic psychologists began to challenge its validity and they continue to do so. Their primary arguments are that no research evidence has been found confirming the validity of learning style assessment instruments or of two propositions the challengers ascribe to learning styles proponents: the invariance of learning styles with time and conditions of instruction, and the "meshing hypothesis" that students' learning in a class is maximized by matching instruction to the individual students' learning styles. The challengers warn that taking learning styles into account when designing instruction is at best useless and at worst can be harmful to students and detract from their learning. Some of the challengers add that there are no such things as learning styles and educators who believe in them are naïvely gullible. (In an online discussion forum two or three years ago, one psychologist equated learning styles with "snake oil.")

Like an uncountably large number of teachers and students, I have found that when properly interpreted and applied, learning styles are useful adjuncts to the invaluable insights about teaching and learning provided by cognitive scientists and educational researchers in recent decades. Although repeated efforts to discredit learning styles have so far had little effect on their widespread acceptance in the general education community, I believe a critical examination of the arguments that have been raised against them might help avoid the loss of a valuable pedagogical tool. I have therefore extended the scope of this essay beyond the history of my personal involvement with learning styles to attempt to clarify modern views of what they are and how they should and should not be used by instructors.

WHAT ARE LEARNING STYLES?

Soon after I started working with learning styles, I adopted a definition by Keefe (1979), who described them as "characteristic cognitive, affective, and psychological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment." That description still comes close to how I view learning styles, but over time I noticed that the part about relative stability left the door open to misinterpretations. I now think of learning styles simply as common patterns of student preferences for different approaches to instruction, with certain attributes—behaviors, attitudes, strengths, and weaknesses—being associated with each preference.

For example, a well-known learning style category is *sensing,* a concept defined by the Swiss psychologist Carl Jung (1971) in his theory of psychological types. Typical sensing learners (*sensors* for short) tend to be methodical in how they work, observant and attentive to details, tolerant of repetitive work (such as checking calculations and replicating experiments), slow at problem solving, and more comfortable with concrete information (physical observations, experimental data, and real-world applications) than with abstract information (general principles, theories, and mathematical models). They tend to respond better to instruction compatible with those characteristics than to instruction that focuses heavily on their less preferred attributes, such as teaching that involves heavy doses of theory, abstract mathematical analysis, and analytical problem-solving exams that only the fastest problem solvers in a class have time to finish.

LS categories are frequently defined in opposing pairs. The opposite of the typical sensing learner is the typical *intuitive learner* (*intuitor* for short), who is relatively comfortable with theory and abstract analysis, easily bored with repetition, inclined to overlook details, and quick at problem solving but with tendencies toward carelessness. A *learning style dimension* is an opposing pair of categories like sensing/intuitive.

The preferences that define a student's learning style may be strong, moderate, or mild. In situations in which typical sensors and typical intuitors are likely to respond differently, students with a strong preference for sensing will behave like the typical sensor a high percentage of the time; those with a moderate preference will do so noticeably more often than they behave like the typical intuitor; and those with a mild preference are only slightly more likely to behave like the typical sensor than like the typical intuitor.

Besides defining learning styles as patterns of preferences that vary in strength from one learner to another, I have found it helpful to explicitly state what learning styles are *not* to make their meaning clear to educators. Table 1 shows three examples of such statements.

Table 1. What learning styles are and are not.

Learning styles are common patterns of individuals' preferences for certain approaches to instruction and personal attributes associated with each pattern. They are not

- pairs of strict either-or categories. The statement "You're either a sensing learner or an intuitive learner, and whichever one you are defines you unambiguously," is false. All sensors sometimes behave like intuitors and vice versa, depending on the learning context and the strength of their preference for sensing learning. The same can be said of any learning style category.
- invariant. As a consequence of education and life experience, someone's preference for a category generally changes in strength over time and may even switch to the opposite category. As they gain experience, learners often gravitate toward balance (i.e., toward mild preferences). Since success in any academic or professional endeavor usually requires skills associated with both categories of most learning style dimensions, as the learners develop skills in a less preferred category, their preference for the opposite category tends to decrease.
- reliable guides to what learners are strong and weak at. Knowing that learners have a preference for sensing tells you nothing about their ability at characteristic intuitive tasks, or for that matter, at characteristic sensing tasks. They may be strong at sensing skills and weak at intuitive skills, strong at both, or weak at both. Consequently, *learning styles should never be used to counsel students on what they should major in or what careers they should pursue*. Individuals with every learning style have succeeded in every field of study and profession.

WHAT IS A LEARNING STYLE MODEL?

The number of attributes that distinguish one type of learner from another is uncountably large. Encompassing most of them in a single theory would be virtually impossible, and even if it could be done, the model would be too cumbersome to be of any practical use. A *learning style model* is a small set of learning style dimensions selected to provide instructors with a useful—but not all-encompassing—collection of guidelines for designing instruction. In essence it is analogous to an engineering model, which simulates the behavior of a complex system based largely on past observations of system behavior and compatibility with established scientific (in this case, cognitive) principles. Like all system models, the usefulness of an LS model increases with its accuracy in representing system (learner) behaviors for a wide variety of experimental conditions.

The origin and structure of the model I co-developed are described in the next section.

THE FS LEARNING STYLE MODEL

For more than the first decade of my half-century-long teaching career, I essentially taught as I had been taught. I prepared my notes, delivered them in lectures, and occasionally answered questions from the few students in the class who ever asked them.

After more than a decade, it dawned on me that high student ratings and teaching awards notwithstanding, I might not be doing all that great a job of teaching. For example, I might be lecturing in my class on chemical reactor design the way I had always done, but now I started to be more conscious of the glazed eyes and nodding heads of my students, and I knew that something was not right. Or I would give a test on material that I had covered in my lectures in excruciating detail and the average would come back 52/100 or worse, and again I knew that things were not working the way they were supposed to. I was putting the information out there, but it was not being absorbed by many of its intended recipients.

A major turning point came in the Spring of 1982 when I spent a sabbatical semester at the University of Colorado and became reacquainted with Dr. Linda Silverman, a childhood friend who had grown up to be an educational psychologist living in Boulder. I learned from her that educational psychology had a lot to tell me about what I was supposed to be doing for a living. In particular, I discovered and was fascinated by the Myers-Briggs Type Indicator (MBTI), which assesses individuals' preferences on dimensions defined by Jung's Theory of Psychological Types (Jung, 1971), and by fundamental differences between people that the MBTI reveals.

I continued to explore the MBTI and type theory after the sabbatical and found information on connections between type differences and learning styles (Lawrence, 1984), and student behavior patterns I had been observing and worrying about in my own classes suddenly started to make sense. In particular, the differences between sensing learners and intuitive learners in the MBTI model beautifully explained the chronic complaint of many undergraduate engineering students about lectures and courses that were "too theoretical" and bore no apparent connection to "the real world." The chances were great that most of those students were sensing learners. I also knew that many of the attributes associated with typical sensors—practical, methodical, observant, attentive to details, and more comfortable with practical applications and hands-on work than with abstract theories and mathematical models—were also characteristics of many excellent engineers and experimental scientists, while most engineering professors, including me, were fond of elegant theories and mathematical models and heavily structured their courses and lectures around those things. In other words, I realized that the abstract (intuitive) teaching style of most engineering professors and the concrete (sensing) learning style of many engineering students were mismatched, with likely negative impacts on the students' motivation to learn and their academic performance. My goal of exploring such mismatches, which was to play a significant role in both my teaching and my research in the decades that followed, originated with that realization.

I soon discovered that I wasn't the first to make a connection between the MBTI learning style model and engineering education. I first heard Edward Godleski (1983) give a research seminar summarizing type differences in academic performance and dropout rates of engineering students, and subsequently learned that a team of faculty members at several institutions had been studying type effects in engineering education since the 1970's (McCaulley et al. 1983). The results of those studies confirmed my suspicion that the dominant instructional paradigm of engineering education was stacking the deck against sensors and certain other types of learners. Years later I used the MBTI in a longitudinal study of engineering students from their sophomore to their senior years and found that the patterns of the students' academic performance and their attitudes toward their instruction followed the predictions of type theory to a remarkable extent (Felder, Felder, and Dietz 2002).

In the years that followed my initial exploration of the MBTI, I started reading everything about learning styles I could get my hands on and found that many models besides the MBTI highlighted mismatches between other LS categories and common teaching styles (Cassidy 2004; Coffield et al. 2004). For example, I learned about visual, auditory, and kinesthetic learning modalities by reading the work of the Dunns (1978), Bandler and Grinder (1979), and Barbe, Swassing, and Milone (1979), and I thought about how ineffective instruction based entirely on lectures and assigned readings must be for visual and kinesthetic learners. I found out about the power of inductive teaching approaches like discovery learning (start with real-world observations and challenges and use them to provide context for inference of general methods and principles) by reading the work of Bruner (1961), and learned that the purely deductive teaching approach I and almost every other engineering instructor I knew had been using (start with general principles and derive your way to mathematical formulations and then to applications) was not necessarily in the students' best interests. I read the work of Kolb (1984) and McCarthy (1980) and Stice's (1987) application of the Kolb learning style model to engineering education, and I recognized that standard lectures do little to facilitate learning in either active or reflective learners and are especially useless to the former. And from Linda Silverman I learned about the holistic mental processes and creative potential of global learners and how the strongly sequential nature of traditional instruction places many of the globals in academic jeopardy, and I found that the sequential/global dichotomy is a feature of several LS models, including those of Gregorc (1985) and Pask (1976).

At some point I came up with the idea of tying these threads together in a new learning style model that would be particularly relevant to the patterns I had observed in my engineering students, and with Dr. Silverman I put together a presentation for the 1987 annual meeting of the

American Institute of Chemical Engineers. Of the many possible dimensions in the models I had learned about, the ones I settled on were sensing/intuitive (from the MBTI), visual/auditory (from modality theory), inductive/deductive (from Bruner's work on discovery learning and the literature on inquiry- and problem-based learning), active/reflective (from Kolb and the extravert/introvert preference on the MBTI), and sequential/global (from Silverman, Gregorc, and Pask). Dr. Silverman and I subsequently turned the presentation into the previously-mentioned paper in the *Journal of Engineering Education* (Felder and Silverman 1988). We didn't give our model a name, but in the years that followed the publication of that paper it has come to be known as the Felder-Silverman (or FS) model.

The 1988 learning styles paper seemed to strike a responsive chord in many journal readers. In the months after it appeared, I got a flood of reprint requests and expressions of thanks for shedding light on teaching problems the letter writers had been struggling with for years but never really understood, and the paper became the second most frequently cited article in the journal over a ten-year period (Wankat 2004).

In the following decade I made two modifications to the original FS model. I had become increasingly concerned about including written prose in the "visual" category, which was the only place to put it when the alternative was "auditory." My suspicion, which was later confirmed by several cognitive science references, was that the brain processes written words in much the same way as it processes spoken words and much differently from how it processes true visual information (diagrams, graphs, pictures, videos, demonstrations, etc.). Motivated by that knowledge, I changed the visual/auditory dimension of the FS model to visual/verbal, with "verbal" encompassing both spoken and written words.

The second change I made in the model was to eliminate the inductive/deductive dimension. I did so partly because I didn't think I could find a valid way to assess a student's preference on that scale. More importantly, I came to realize that induction is how most of what we know—in science and in the rest of life—was originally discovered, and that inductive teaching methods (guided inquiry, project- and problem-based learning, just-in-time teaching, and others) generally lead to greater learning than traditional lecture-based deductive teaching can produce (Prince and Felder 2006, 2007). Even if I could have come up with a trustworthy assessment of a student's preference for inductive or deductive teaching, I didn't want to give instructors an excuse to use a proven inferior teaching approach ("many of my students say they prefer deductive teaching"), and so I dropped the dimension from the model.

THE INDEX OF LEARNING STYLES

In the early 1990s, Barbara Soloman, then the Coordinator of Advising for the N.C. State University First-Year College, started using the FS model to help her freshman advisees understand difficulties they might encounter in their courses. Around 1993, she and I began to develop an instrument to assess preferences on each dimension of the model, an effort resulting in the original version of the *Index of Learning Styles* (ILS). We administered the ILS to several hundred students and subjected their responses to internal consistency reliability assessment and confirmatory factor analysis. Items that did not correlate significantly with the appropriate factor or correlated significantly with several factors were dropped and replaced with new items to produce a second version of the instrument, which we installed online in 1996 (Felder and

Soloman n.d.). The massive quantities of response data subsequently collected were used to validate the instrument in several published studies (Felder and Spurlin 2005; Litzinger et al. 2007; Zywno 2003). Since it went online, it has been accessed by millions of users and used in many research studies around the world in both STEM and non-STEM disciplines.

WHY ARE INDIVIDUAL STUDENTS' LEARNING STYLE PREFERENCES HELPFUL BUT NOT NECESSARY FOR INSTRUCTORS TO KNOW?

Assessing individual students' learning style preferences and sharing the results with the students has a number of benefits, including making students aware of some of their probable learning strengths and helping them identify areas in which they might encounter academic difficulties. Another benefit is that if students are working in teams, knowing their own and their teammates' learning style attributes can help them better understand one another, which in turn can lead to resolution of what might otherwise be intractable interpersonal conflicts.

On the other hand, whether Mary is a sensor and Ben an intuitor or vice versa should make very little difference to their course instructor. What *is* important for instructors to know is that every course contains students with each preference, and that to be effective, instruction should routinely address all categories of a selected learning style model rather than heavily favoring one category over its opposite, as much traditional instruction does. How to achieve such a balance is the main subject of most of my papers on learning styles (Felder n.d.), and this paper is not the place to restate them all (although several illustrative examples are given in the Summary). It may be appropriate, however, to paraphrase the advice that concluded the 1988 paper (Felder and Silverman 1988):

> *The idea is not to adopt all the techniques recommended for balancing instruction among different learning style preferences, starting next Monday. It is rather to pick a few that look reasonable to you and give them a fair try (as opposed to just trying them once and abandoning them if you don't get immediate positive results); keep the ones that work for you and drop the others; and try a few more in the next course you teach. In this way a teaching style that is both comfortable for you and effective for your students will evolve naturally and relatively painlessly, with a potentially dramatic effect on the quality of learning that subsequently occurs.*

WHAT ABOUT THOSE PSYCHOLOGISTS WHO SAY LEARNING STYLES HAVE NO PLACE IN INSTRUCTIONAL DESIGN?

When I began learning about and then working with learning styles in the 1980s, they had started to interest a rapidly growing number of educators with little attendant controversy. That situation changed in subsequent decades when a group of mostly academic psychologists began to challenge the concept of learning styles, with attitudes ranging from scholarly questioning to outright hostility. The challenges still continue, with new papers "debunking" learning styles coming out every one to two years.

As I noted in the introduction, virtually all of the published challenges are based in part on the meshing hypothesis, an assertion attributed to LS proponents that matching instruction to students' learning styles maximizes the students' learning. The challengers propose that since the meshing hypothesis has not been validated by rigorous scholarly research, learning styles should never be considered when designing instruction. Some add that the LS proponents believe learning styles are attributes of individual learners that are invariant with time and conditions of instruction, and the challengers take a lack of evidence for that belief as another proof of the invalidity of learning styles. Still other challengers discredit learning styles based on a lack of evidence for the validity of the VARK (visual, aural, read-write, kinesthetic) learning style model (Hyerle n.d.; Leite et al. 2010), which is one of about nearly 100 widely disparate published models. The implication, which is not supported by evidence, is that no learning style model has ever been successfully validated. Finally, many challengers refer to extensive harm to students that has resulted from the introduction of learning styles into instructional design. If they cite any specific harm, which most do not, it generally stems from instructors subscribing to the meshing hypothesis or using learning styles for inappropriate purposes such as curriculum or career counseling, as in "*Because you are a [learning style category], you [should/should not] go into [a designated discipline or career].*"

Following are illustrative quotations from several debunking papers. Note the consistent appearance of the meshing hypothesis supplemented by the invariance of learning styles as alleged basic tenets of learning style theory.

- "*Proponents of learning-style assessment contend that optimal instruction requires diagnosing individuals' learning style and tailoring instruction accordingly*." (Pashler *et al.* 2009)
- Knoll et al. (2017) mention nine learning style models and follow them with this statement: *"The basic assumption behind these diverse models and measures is that once a student's learning style is identified, the way in which learning material is presented can be tailored to the student's learning style. This idea is known as the meshing hypothesis, which states that students learn best when instructional style is matched with learning style."*
- *"Learning styles theories make two straightforward predictions. First, a learning style is proposed to be a consistent attribute of an individual, thus, a person's learning style should be constant across situations. Consequently, someone considered an auditory learner would learn best through auditory processes regardless of the subject matter (e.g., science, literature, or mathematics) or setting (e.g., school, sports practice, or work. Second, cognitive function should be more effective when it is consistent with a person's preferred style; thus, the visual learner should remember better (or problem-solve better or attend better) with visual materials than with other materials."* (Willingham, Hughes, and Dobolyi 2015).
- *"This present research also demonstrates that even those students who did utilize study strategies consistent with their VARK dominant category had no greater success in the course. These present findings, along with extensive prior studies about the myths of learning styles (e.g., Pashler et al. 2009) provide strong evidence that instructors and students should not be promoting the concept of learning styles for studying and/or for teaching interventions."* (Husmann and O'Loughlin 2019)

Many other references challenging the validity of learning styles and warning against using them to design instruction base their arguments on the same premises (for example, Dekker *et al.* 2012; Kirschner 2017; Newton and Miah 2017; Riener and Willingham 2010; Wikipedia n.d.). They offer definitions of learning styles and statements of what their proponents claim about them (specifically, the validity of the meshing hypothesis and the invariance of learning styles with time and across all situations), possibly name a single learning styles model (almost always VARK) and use it as a general definition of learning styles, and cite a lack of evidence for the validity of those claims and that model to justify their judgment that under no circumstances should learning styles be used to design instruction. Some extend their argument to conclude that there are no such things as learning styles.

Those challenges are seriously flawed. It's easy enough to invalidate a concept if you get to define the concept yourself. If you define learning styles as students' preferences for certain types of instruction that remain invariant regardless of the subject of the instruction, the pedagogical style of the teacher, and the student's mood at the moment of instruction, I would be the first to agree that there are no such things as learning styles. I've never encountered anyone within the past three decades who works with learning styles and subscribes to that definition, however. On the other hand, if you define learning styles as patterns of student preferences that vary in strength and change with time and instructional context, denying their existence would be tantamount to proposing that all students have identical permanent context-independent preferences for instructional approaches, which not even the learning styles debunkers claim. Moreover, even if one learning style model (such as VARK) can be discredited for lack of adequate validation, it does not automatically invalidate all other models.

Most importantly, finding a lack of evidence for the validity of the meshing hypothesis (matching teaching to students' learning styles maximizes learning) in no way invalidates the concept of learning styles. Most proponents of learning styles explicitly reject the meshing hypothesis, among other reasons because it's impossible to match teaching to the learning styles of all students in a class simultaneously. Whenever the instruction matches one style, it automatically mismatches one or more elements of the other styles represented among the students. Besides, even if it were possible to match teaching to the learning styles of all the students in a class simultaneously, for reasons that follow it would not be desirable.

Here is the predominant view of the role of learning styles in the design of instruction, which goes back to some of the earliest and best known formulations of the concept: (1) each learning style category (sensing and intuitive, visual and verbal, etc.) has associated with it certain characteristic skills; (2) skills associated with both categories of each learning style dimension are important for success in most professions; (3) the optimal teaching approach for a course is to balance the preferences of students with different learning styles rather than strongly favoring some preferences over their opposites; (4) the optimal balance depends on the subject, the level of the course, the prior knowledge of the students, and the familiarity of the instructor with alternative teaching strategies. When a good balance is achieved, all students are taught sometimes in their preferred manner so they are not too uncomfortable to learn, and sometimes in their less preferred manner so they are forced to stretch and grow, building important skills that they might never develop if their preferences were exclusively catered to.

One of the most widely-used learning style models is the experiential learning model of David Kolb, developed in the 1970s and popularized by Kolb (1984, 2014). Kolb's central idea is not to teach each student according to his or her style preferences but rather to *teach around the cycle,* sequentially addressing the preferences of students with different styles. The validity of Kolb's Learning Styles Inventory has been questioned, but again, it's not necessary to know which students are accommodators, divergers, assimilators, and convergers. If the instructor teaches around the cycle, all students will be taught well regardless of their learning style. The same point has been made in the context of the MBTI model (Lawrence 1979, 1984, 1993, 2009) and the FS model (Felder and Silverman 1988; Felder 2010; Felder and Brent 2016, 276–278), with all of those references offering specific suggestions for teaching all students in a manner that cycles through the preferences of all of the types of learners defined in the different models. Although those references and others that advocate balanced instruction are frequently cited and the idea of teaching around the cycle is now almost a cliché in the learning styles literature, the references, models, and idea of achieving balanced instruction as the goal of learning styles are invariably ignored in LS debunking attempts.

A criticism of learning styles that has greater merit than those mentioned above is that they are based entirely on cognitive differences among students and fail to consider social factors such as inequalities based on sex, gender identity, race, and socioeconomic status, all of which can affect academic achievement as much as cognitive factors do. This paper is not the place to discuss social issues in detail, among other reasons because other authors have done so extensively (e.g., Chubin, May, and Babco 2005; Quaye, Harper, and Pendakur, 2020; Reynolds 1997); however, the idea that social contextualization should always be incorporated into instructional design is worth noting in any reference on effective pedagogy.

SUMMARY

- Learning styles are common patterns of student preferences for certain forms of instruction and student attributes associated with each pattern. Opposing learning style categories (such as sensing and intuitive) are not simple either/or labels: an individual's preference for one category or the other may be strong, moderate, or mild, and if a preference is mild the individual is almost as likely to behave in the less preferred category as in the preferred one. The strength of an individual's preference for a category and possibly the preference itself may change with the individual's education and life experience and with the subject and context of the instruction.
- As the critics of learning styles correctly claim, the meshing hypothesis (matching instruction to students' learning styles maximizes learning) has no rigorous research support, but the existence and utility of learning styles does not rest on that hypothesis and most proponents of learning styles reject it. The optimal teaching style strikes a balance between the categories of each dimension of whichever learning styles model a teacher selects as a basis for designing instruction. When that balance is achieved, all students are taught sometimes in their preferred categories, so they are not too uncomfortable to learn, and sometimes in their less preferred categories, so they can build critically important skills they might never acquire from matched instruction.
- Acquainting students with their learning style preferences can increase their awareness of some of their natural learning strengths and alert them to learning needs which, if

unaddressed, could create academic difficulties for them. Learning style preferences provide no indication of what students are and are not capable of, however, and so they should never be used as a basis for curriculum or career advising.

The idea of teaching to address all categories of a learning styles model rather than attempting to match instruction to individual students' learning styles preferences is neither radical nor new, and specific suggestions for how to do it are common in books, journal articles, and workshops on effective teaching. For example:

> *Teach basic principles and theories, but only in the context of their real-world applications*. *Don't just lecture—provide opportunities in class for individual and group practice of course-taught methods and metacognitive reflection on the outcomes*. *Present information both visually and verbally rather than making almost everything verbal* (as is usually done in fields other than art, architecture, and design) (Felder and Silverman 1988).

These guidelines and many others that involve balancing the needs of opposing learning styles are all supported by both cognitive science and empirical classroom research (see, for example, Ambrose et al. 2010; Biggs and Tang 2011; Felder and Brent 2005, 2016; Hodges 2015; Sousa 2016). While they can of course be taught without mentioning learning styles (which instructional developers uncomfortable with the concept of learning styles are always free to do), a good learning style model provides an effective conceptual framework for them. My experience giving teaching workshops suggests that once instructors recognize their own preferences as learners in descriptions of learning styles, they also become aware that many of their students have different preferences that their teaching may be failing to address. Most of the instructors then go on to grasp the value of balance and become receptive to the idea of seeking more of it in their teaching, and many subsequently follow through on that intention (Felder and Brent, 2010). The same level of understanding may not be easily gained through a series of seemingly unconnected teaching tips, however solid the scientific evidence for the tips may be. The absence of a unifying conceptual framework may have something to do with the relatively low impact cognitive science has so far had on mainstream education (Chew and Cerbin, 2017).

In the past several decades, millions of people have accessed online learning style assessment instruments and learned something about their own learning patterns and preferences; innumerable teachers have learned about the preferences of their students and gained insights into how to avoid teaching that heavily favors some preferences over others; and the widespread negative consequences of using learning styles for instructional design that learning styles critics have been warning about for years have not materialized. As long as instructors don't try to match their teaching to their students' learning style preferences or to use those preferences as indicators of what students are and are not capable of doing, learning styles will continue to be extensively used in education, and no one—students, teachers, or disapproving psychologists—will be harmed in the process.

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