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PRINCIPLES OF TAKING LESSONS USING WORLD STAN DART TECHNOLOGIES IN TEACHING BIOLOGY

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Annotation: Teachers aspire to have all of their students learn. This aspiration of reaching all students spans disciplines, age levels, and all varieties of institutions. Most teachers do so out of a genuine love for their discipline and a desire to share the wonder of their chosen field with others. Science teaching is no different than other disciplines in this respect. However, try as we may in science, the lack of diversity apparent in the statistics of who chooses to pursue scientific disciplines professionally suggests that we still have much to learn about how to reach all students.

Key words: biology, zoology, major factor .

In their book, Talking About Leaving: Why Undergraduates Leave the Sciences, Elaine Seymour and Nancy Hewitt (1997) provide ample evidence from analysis of previous studies and their own research that two major factors contribute to choices students make about pursuing science majors and their satisfaction with science as a choice of major—classroom climate and faculty pedagogy. These factors underlie many of the reasons“ switchers” leave science majors and many of the complaints“ nonswitchers” have about their education in science (Seymour, 1997). Competitive class climate, strict grading, overpacked curricula, and the overt “weed-out” attitude of some faculty are cited most often as criticisms and reasons for abandoning a science major. However, Seymour and Hewitt (1994) emphasize that “switchers” and“ nonswitchers” are not identifiably different populations of students, in that academic ability is not a reliable predictor of who stays and who leaves. This leads to the conclusion that science classroom environments, instructor teaching styles, and the process of instructional selection is unintentionally causing the loss of able, interested students from the profession of science. If we lose students precisely because they learn differently and think differently than those who currently dominate the profession and teach them, we lose a potential source of future creativity in our discipline. Sheila Tobias (1990), author of They're Not Dumb, They're Different, writes that “not every student who doesn't do science can't do science; many simply choose not to.” Tobias identifies the selection process of introductory science courses as a driving force against diversifying participation, and thus diversifying intellectual approaches within the profession.

Consider the environment that characterizes most science classrooms, particularly in the late 1980s when Sheila Tobias conducted her research in these classrooms. It is usually organized by an individual—faculty or a teacher of grades 6 through 12—who survived, if not thrived, in the fairly traditional pedagogical settings of teacher-centered direct instruction, mostly dominated by lecture-based approaches to teaching. The dominance of lectures and direct instruction, especially at the high school and undergraduate level, in an attempt to transmit the large body of accrued scientific knowledge efficiently, has created a relative monoculture of teaching styles in these settings. Although a variety of strategies have been developed to broaden access for students through more varied instructional strategies (see, e.g., Allen and Tanner, 2003; Tanner et al., 2003), these approaches are not widely used for a variety of reasons. This is not to say that lectures have no place in the pedagogical toolbox of a science instructor, but rather that this tool tends to be overused (Powell, 2003). As such, teaching strategies used in science classrooms have created a situation that

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we'll refer to here as Instructional Selection, in which by our very choice of pedagogy, we are constructing environments in which only a subset of learners can succeed. Understanding the variety of learning styles that students bring to a science classroom will not only help some students learn more science, but also help more students learn any science.

To provide open access to science learning and encourage a broader spectrum of students to pursue studies in the sciences, we—as teachers, instructors, and faculty—must begin to address the diversity of learning styles among the students in our classrooms. So, what is a learning style? An individual's learning style can be defined in many ways, including, “the complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store, and recall what they are attempting to learn” (James, 1995) or, alternatively, “the preference or predisposition of an individual to perceive and process information in a particular way or combination of ways” (Sarasin, 1998). From a biological perspective, the brain is the organ of learning, and as such, a learning style is likely to be a complex, emergent interaction of the neurophysiology of an individual's brain and the unique developmental process that has shaped it through experience and interaction with the environment. Learning style, thus, is a phenotypic characteristic of an organism like any other. Given the plasticity of the human brain and its propensity to learn and likely change synaptically over time, learning styles should be considered to be flexible, not immutable—an individual's learning style could be actively adapted, to a certain extent, to different learning environments.

The study of human learning styles is a well-established field within the discipline of cognitive psychology. Shelves of books and hundreds of papers by leading researchers in the field are beyond the scope of this short introduction to learning style theory. To provide entry into the core ideas for interested science faculty, we have chosen to briefly explore three accessible frameworks for characterizing differences in the way learners prefer to learn: the VARK, Multiple Intelligences, and Dimensions of Learning Styles in Science. No one school of thought is superior or inferior to the others, and those presented here are but a sampling of the ideas in this field of cognitive psychology research. There are many common strands and themes among these examples. Other approaches to describing and categorizing learning styles have been proposed that are not dissimilar to the ideas presented here (Honey and Mumford, 1982; Kolb, 1984, 1994). In particular, Isabel Briggs Meyers and her mother, Katherine Briggs, adapted the theories of Carl Jung to produce the Meyers-Briggs Type Indicator assessment, which explores the connection between personality, temperament, learning style, and career choices and is commonly used in both corporate and academic environments (Meyers and McCaulley, 1986; Meyers-Briggs, 1980). It is important to keep in mind that all of these frameworks and research literature on understanding learning styles are attempts to simplify what is fundamentally a complex issue; namely, who we are and how we learn.

Sensory Modalities of Learning: The VAK Framework

Perhaps everyone has heard the refrain, “But I'm a visual learner” or “I'm an auditory learner.” One of the oldest characterizations of learning styles has been to define a learner's preferred mode of learning in terms of the sensory modality by which they prefer to take in new information. VAK is an acronym that stands for three major sensory modes of learning: visual, aural, and kinesthetic, depending on the neural system with which a learner prefers to receive information. More recently, this sensory framework has been expanded to VARK to include reading/writing as an additional type of mixed-sensory learning modality (http://www.vark-learn.com/english/index.asp). Although all learners can use all of these sensory modes in learning, one mode is often dominant and preferred.

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Visual learners learn through seeing and prefer to learn through drawings, pictures, and other image-rich teaching tools. Auditory learners learn preferentially through hearing and are adept at listening to lectures and exploring material through discussions and might need to talk through ideas. Reading/writing learners learn preferentially through interaction with textual materials, whereas kinesthetic learners learn through touching and prefer learning experiences that emphasize doing, physical involvement, and manipulation of objects. In fact, as we progress through schooling in the United States, pedagogy often emphasizes kinesthetic learning with young children through the use of models and manipulatives, moves on to more visual learning as language develops in the elementary school years, and culminates in primarily aural learning in the form of lectures, accompanied by increased reading and writing, in the high school and college years. An exception is often the college laboratory setting, which continues to offer opportunities for mature learners to use manipulatives in building science knowledge. Most instructors organizing introductory science courses will find that the material can be organized to include all of the above types of learning modalities, but the reality of large class enrollments and limited budgets can make this a challenge.

Developed in 1987 by Neil Fleming, the VARK Inventory is a tool for assessing where an individual's preferences for learning lie within these sensory domains (see http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/vark.htm).

Deconstructing Intelligence: Howard Gardner's Theory of Multiple Intelligences

In contrast to other characterizations of learning styles, Howard Gardner's approach to defining learning styles stems from the notion that the concept of intelligence has been too narrowly defined. Gardner argues that psychologists, in defining intelligence and designing instruments to measure and compare intelligence across individuals, have focused on a singular, unitary notion of intelligence. In Gardner's view, the dominant formal IQ test only measures one type of intelligence, yet humans can excel in multiple areas of intelligence. In his 1983 book Frames of Mind, Gardner introduced his now widely discussed Theory of Multiple Intelligences. In addition to linguistic-verbal intelligence and mathematical-logical intelligence, the two major cognitive skill sets tested by IQ instruments, Gardner proposed another initial six domains of intelligence . Gardner points out that although these categories of intelligences might only represent a subset of the range of human abilities, they are likely to be a more accurate representation than a singular notion of intelligence. In exploring the multiple intelligence framework of Gardner, one will find vestiges of the sensory modality approach to learning styles described above. Visual-spatial intelligence is characterized by facility with images and graphic information and bodily-kinesthetic intelligence involves facility with physical manipulation of objects, the body, and other modes of physical interactions (Gardner, 1983). In addition, Gardner proposes two intelligences that are characterized either by particular talents in understanding and interacting with others (interpersonal intelligence) or by a talent for self-perception and metacognition about oneself (intrapersonal intelligence). To define a category of intelligence, Gardner's theory requires that several criteria be met, including distinction of intelligences through psychological tests, the potential for localization in the brain, the existence of savants who excel within the realm of a single intelligence, and a potential evolutionary history. This last aspect of defining intelligences is particularly intriguing biologically, given the existence of acute spatial skills in reptiles and insects and the evidence of adept musical skills in birds important for marking territory and attracting mates . Again, an introductory science course can readily be organized to draw on most of these diverse intelligences by including a variety of learning activities throughout a course, such as lectures rich with visual information, discussions that promote student-

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student interactions, group projects and presentations that allow for creative elements, and laboratory investigations that engage learners in the physical doing of science.

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