

A Comparison of Learning Style Models and Assessment Instruments for University Graphics Educators

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Abstract

Kolb (2004) and others have defined learning style as a preference by which students learn and remember what they have learned. This presentation will include a summary of learning style research published in the Engineering Design Graphics Journal over the past 15 years on the topic of learning styles and graphics education. The presenters will also examine several learning style models and why they are important to the university graphics professor. Discussion will include a review of some of the learning style tests that are now available on the market. We will discuss how and why higher education student learning has changed in the last decade and introduce the concept of the social construction of technology.

Introduction

Lifelong learning is valued in American society more than ever. Understanding how diverse people learn is a key to successful teaching and learning. The way each human being processes, retains, integrates, and focuses on new information and skill sets determines his or her preferred learning style. Professors and students must begin the process with self-knowledge through assessments. The next step is developing a plan of action, and then finally implementing any changed behavior.

If graphics professors understand their teaching style, as well as recognize the students' learning styles, there should be less conflict and stress. Mismatched working styles resulting from the student learning one way and the professor teaching another, causes incompatibility (Prashnig, 2000). Understanding how one learns and eventually works in the professional workplace, involves understanding how one performs tasks, makes decisions, solve problems and concentrates.

Learning and working styles are influenced by both learned behavior and innate factors that make human beings different from one another. People have control over the learned behavior — their attitudes and habits they have acquired — and, therefore, these can be changed if they

begin to interfere with school and one's job. But first one must understand how a student learns.

How Learning Occurs

Bloom's Taxonomy

Preferences for thinking, processing thoughts, and approaching work determine how we learn. Because learning preferences and instructional activities can range from simple to complex, we must consider levels of thinking within different learning styles.

The basic premise of how students in higher education store and retrieve information is presented in Bloom's taxonomy, which is one of the most widely used theories on learning styles in the academy (Officeport.com, 2004). It is based on a study that was conducted by Benjamin Bloom. The findings indicated that there are three types of learning domains: (1) cognitive (knowledge and the development of intellectual attitudes and skills), (2) affective (emphasizing feeling and emotion), and (3) psychomotor (concerned with motor skills). Compilations for the cognitive and affective domains were produced, but none for the psychomotor domain. This oversight was justified by the higher education committee's explanation that they had little experience in teaching manual skills.

Within the cognitive domain Bloom identified six levels from simple recall or recognition of facts, at the lowest level, through increasingly more complex and abstract mental levels, to the highest order, which is classified as evaluation. The six levels are knowledge, comprehension, application, analysis, synthesis, and evaluation. Although Bloom didn't apply the taxonomy to learning style, Butler (1995) found that the quality of a student's outcome in an instructional activity depends as much on learning style, as on the level of the activity. Butler found that matching learning styles with different levels of thinking allowed students to learn most efficiently, effectively, easily and with the greatest enjoyment. She also found that a guided mismatch of learning skills through learning experiences helped some students gain and practice skills that they didn't use naturally.

Engineering Design Graphics Journal Review of Learning Styles

There has been very little published in the Engineering Design Graphics Journal about learning styles, although there has been a long history of papers on spatial visualization. In 1996, Miller compiled a historical review describing the interests, research, committees and projects of Engineering Design Graphics Division members dating back to the early 1930's. These included publications about applied as well as theoretical spatial visualization. A project headed up by Clair V. Mann in the 1930's resulted in the development of several tests measuring visualization ability (Miller, 1996). Although the focus of many of these projects was not learning styles, it can be argued that the focus of many of these projects was the innate ability or aptitude that students have and how the capacity students have in that area is assessed. In 1955, R. R. Worsencroft (Miller, 1996) conducted a study with objectives that included determining the incidence of visualization in engineering students, and determining study experiences responsible for the development of visualization ability.

In 1966, A. S. Levens claiming that graphics is a mental process, proposed a curricular approach emphasizing open-ended conceptual design projects to develop a "thought model" for students. In 1977, Paul DeJong conducted a pilot study on visualization. He observed that experi-

ence improved analytical and visualization abilities and that "a graphics course should increase students' visualization abilities and emphasize the ability to synthesize and communicate ideas" (DeJong, 1977). This interest in spatial visualization has been sustained until the present day.

In 1990, Bertoline and Miller noted that visualization is developed in various stages as individuals mature, and that this ability is of vital importance for any unrelated areas including engineering. Sexton (1992), Weibe (1992), Ross and Aukstakalnis (1993), Bowers (1993), and Devon, et al. (1994), among others, wrote about different aspects of student learning and visualization in the Engineering Design Graphics Journal in the early 1990's.

Sheryl Sorby (2000) has written extensively about spatial abilities and their relationship to effective learning. Sorby, Gorska & Leopold (2003) have examined the gender differences in background in visualization ability for students enrolled in the United States as well as internationally.

Nancy Study examined the haptic abilities of first-year engineering students in her study using the Successive Perception Test I to measure Visual-Haptic Tendencies. According to Lowenfeld's 1945 theory, subjects are visual, haptic, or indefinite" (Study 2003). Study states that "haptic students rely predominantly on non-visual sensory stimuli to orient themselves with their environment while visual subjects tend to prefer optical experiences to other sensory input. Indefinite students are neither strongly visual or haptic" (2002). Study concludes that because the "haptic tendencies of her test subjects were not to the exclusion of high visual tendencies, and with research showing that the sense of touch contributes significantly to the creation of mental models despite the trend toward the use of animations and simulations, the use of physical objects as examples and other methods of haptic interaction should be considered in ordinary classroom environments to supplement instruction and testing in visualization" (Study 2003).

Learning Style Models

The term *learning style* is used to identify individual learning differences (Butler, 1993). Much research has been done to assess how the

human mind operates, how it perceives and processes information. As a result, many learning models have been developed by which an individual's predominant learning style can be assessed. Educators can start by assessing their own teaching styles and compare them to an assessment of their students learning styles. Butler (1995) points out that a teacher can "bridge" to the learner through attitude and action. The teacher can adjust his/her attitude to that of the learner and see things from their learning perspective. Actions in the way of suggestions to lead the learner through the task in another way more in tune with his/her style can follow. Several of these learning models are presented for comparison.

Myers Briggs

One of the most popular learning-style assessments is the Myers Briggs Type Indicator (MBTI), which is based on Bloom's Taxonomy. Several teaching approaches specifically appeal to specific learners.

Assessment

There are 16 learning styles categorized in the Myers-Briggs Type Indicator, which are a combination of the following four preferences: (1) extraversion versus introversion, (2) sensing versus intuition, (3) thinking versus feeling, and (4) judging versus perceptive. These preferences are determined by a 126-item testing instrument, which takes less than an hour to complete.

Learning Style Indicators

Extraversion/Introversion

Extroverts get recharged by being around people. They are action-oriented. The old adage that you don't really know a concept until you try to teach it applies to extraverted students. They learn by teaching others and especially like working in groups.

Introverts can be sociable, but need to recharge by having quiet reflective time in their inner world of abstract thinking, conceptualization, and brainstorming ideas. They want to understand what makes the world function. Introverts need to have a frame to connect the pieces of information. They need to grasp the understanding of the global perspective in order for knowledge to occur.

Faculty can help introverts in their learning process by teaching students how to categorize and link pieces of information through flowcharts,

mapping, and compare/contrast tables. This process, which is often referred to as "chunking," gives introverts an opportunity to master the material in the lesson. Extroverts may not appreciate this exercise.

Sensing/Intuition

Sensing learners rely on factual information. They are detail oriented and prefer linear, organized, and structured lectures. When teaching sensing students, a teacher should present a problem and engage their curiosity. The solution should be one that they can draw from previously learned materials and experiences, but involve thinking just beyond the reach of their present knowledge in order to be challenging, but not frustrating. When working with sensing students, a teacher should first list the goals of the lesson. Then discuss what needs to be done in order to achieve these goals. Then discuss the reason why this is important by linking how to apply the theory to the application.

Intuitive students rely on their sixth sense of intuition in order to receive and integrate information into a "big picture." Intuitives are able to see patterns and relationships to pieces of information, where others only see chaos. Discovery learning or the "Why?" approach helps intuitive students discover the theory. Combining both types of students in a small learning team is to everyone's advantage. The sensing student will identify the facts of the exercise and the intuitive student will show how the elements are integrated into a framework.

Thinking/Feeling

Thinking learners process information logically and through analysis. They value justice. These students are predominantly male. University faculty are predominantly thinking learners. Ambiguity is frustrating to thinking students. They tend to favor student action-oriented objectives and specific objectives, including rote, integrated, and critical thinking.

Feeling students rely on human values to make decisions. They value harmony and tend to be great negotiators and persuaders. Feeling students enjoy group work, as long as there is collaborative win-win behaviors and goodwill among the members.

Judging/Perceptive

Decisive, self-disciplined learners, who plan

things out are judging learners. These students are task oriented and committed to deadlines. Judging students do best when they learn speedwriting by omitting the vowels and using a split page method of note taking — shorthand on one side of the page and commentary on the other side. Color coding and highlighting helps judging students learn better. When analyzing information, judging students often jump to conclusions too quickly. It is helpful to revisit the analysis and play “devil’s advocate” to give these learners an opportunity to consider the best solution.

Perceptive students tend to wait until the last minute to get their assignments in. Even though they are perceived lazy, they are actually seeking information until the last possible moment. A teacher can break up an assignment into smaller pieces and give interim feedback to keep the perceptive student on task (Brightman, 2004).

Gagné’s Theory of Learning Styles

Robert Gagné, who has taught at Princeton, University of California-Berkeley, and Florida State University, bases his theory of learning styles on intellectual skills and eclectic behaviorism. The codification of competency-based learning, behavior modification, and internal and external conditions creates Gagné’s taxonomy of learning outcomes and conditions of learning theory. His theory, which remained popular in his book from 1965 to 1985, has been embraced by instructional designers. His approach to learning styles is that learning is comparable to a computer’s information processing of input-output through the central nervous system (CNS). Learning takes place, according to Gagné, through attention, encoding, and retrieval of information (Gagne, Briggs, & Wagner, 1992).

Assessment

Gagné examines five major categories of learning that he identifies as: (1) verbal, such as learning an English word, (2) intellectual skills, such as learning a math formula, (3) cognitive strategy or logical reasoning, (4) attitude, and (5) motor skills. Different internal and external conditions are needed for each.

Learning Style Indicators

Gagné believes that instruction can be taught sequentially through nine instructional events that he says are required in order for effective learning

to take place. They are as follows: (1) The learner must be receptive; (2) The learner must know what to expect and understand the objectives that will be met; (3) There must be prior learning retrieval; (4) There must be selective perception and preset stimulus material; (5) Guidance for the learner must be provided, resulting in systematic encoding; (6) Performance must be elicited; (7) Feedback and reinforcement must be provided; (8) Performance must be assessed in the form of information retrieval; and (9) There must be an effort to enhance retention and transfer. All these events are the basis for instructional design and technology selection in higher education (Gagne, Briggs, & Wagner, 1992).

Kolb Learning Style Inventory

The Kolb Learning Style Inventory is based on a four-stage experiential learning theory. The four-stage cycle includes (1) a concrete experience which is the basis for (2) observation and reflection which in turn leads to (3) a “theory” from which implications for action can be determined and finally (4) the theory serves as a guide to create new experiences. (Zanich, 1991).

Kolb and Fry (1975) identified four abilities that lead to effective learning: (1) concrete experience, (2) reflective observation, (3) abstract conceptualization and (4) active experimentation. During stage one, concrete experience, the learner gets involved in a new experience. In stage two, reflective observation, the learner watches others doing something or develops observations about an experience. In stage three, abstract conceptualization, the learner creates theories to explain the observations. Stage four, active experimentation, requires the learner to use the theories to solve problems or make decisions.

Assessment

The Kolb model focuses on how the learner perceives and processes information (Kelly, 1997). It assesses the individual’s abilities along two spectra: (1) concrete experience to abstract conceptualization, and (2) active experimentation to reflective observation. The Learning Style Inventory establishes the learner’s strengths in these learning modes through self-assessment not established standards (Kelly, 1997).

Learning Style Indicators

Kolb summarized four different learning

styles: (1) converger, (2) diverger, (3) assimilator, and (4) accommodator. The *converger* is strong in abstract conceptualization and active experimentation learning abilities, and tends to be unemotional and prefer “things” to “people,” which is typical of an engineer (Zanich, 1991). The converger is strong in the practical application of ideas (Kolb, 2004).

The *diverger* is best at concrete experimentation and reflective observation, and tends to be imaginative, emotional and interested in people, which is typical of a counselor (Zanich, 1991). The diverger is strong at generating ideas and seeing things from a different perspective. (Kolb, 2004).

The *assimilator* relies on his/her abstract conceptualization and reflective observation learning abilities and is more interested in abstract concepts than people, which is typical of a researcher (Zanich, 1991). The assimilator excels in inductive reasoning and creating theoretical models (Kolb, 2004).

The *accommodator* excels at concrete experience and active experimentation and is at ease with people and easily adapts to different situations, much like a typical salesman (Zanich, 1991). The accommodator solves problems intuitively (Kolb, 2004).

Hartman (1995) suggests formats for addressing the four learning styles. Whereas lectures, papers and analogies work well for abstract conceptualization, simulations and case studies are better for the active experimentation. For concrete experimentation, laboratories and field work are helpful and logs and journals work well for reflective observation.

The Ned Herrmann Whole Brain Dominance Theory

The Whole Brain Concept was developed by Ned Herrmann, when he was a senior manager at General Electric in the 1970's. Herrmann combined Roger Sperry's research on right/left brain theory and Paul MacLean's model of rational brain, intermediate brain and primitive brain with his own observations to create a four quadrant model that graphically represents thinking style preferences. Herrmann divided the brain's functions into four distinct metaphorical quadrants, each with its own language, values, and ways of

knowing (Lumsdaine, Lumsdaine, & Shelnutt, 1999). According to Herrmann (1995), each person is a unique mix of these modes of thinking preferences and has one or more dominating quadrants. The stronger our preference is for one quadrant, the more uncomfortable we are thinking and using the other quadrants. Everyone has some capabilities in each of the four quadrants and uses them to perform different functions. By understanding our own particular preferences, we can gain powerful insights into why we do the things we do, and why others don't always do what we expect.

Abilities Assessed

Herrmann developed the Herrmann Brain Dominance Instrument (HBTI™), a tool with 120 items that gathers data on thinking preferences. The resulting profile explains how someone prefers to think, learn, communicate and make decisions. The profile measures preference, not competence. It identifies in individual's instinctive approach to thought – emotional, analytical, strategic or structural.

Learning Style Indicators

The four metaphorical quadrants determined by Herrmann may be characterized as: (1) A-logical, (2) B-organized, (3) C-interpersonal, and (4) D-imaginative.

Quadrant A thinking is factual, analytical, quantitative, logical, rational and critical. This part of the brain deals with data analysis, risk assessment, analytical problem solving, and making decisions based on logic and reasoning. Quadrant A thinkers are achievement-oriented and performance-driven. Lawyers, engineers, computer scientists tend to be strong quadrant A thinkers. These thinkers organize information logically; analyze problems and solutions, and judge ideas based on facts, criteria and logical reasoning.

Quadrant B thinkers are organized, detailed and like things sequential and planned. They tend to be procedure oriented, persistent, and disciplined while maintaining policy and procedures. Quadrant B thinkers are organizers who prefer to learn by outlining, checklists, and practice. They read directions carefully, take comprehensive notes, and find practical uses for knowledge learned. Planners, administrators and many engineers are strong quadrant B thinkers.

Quadrant C thinkers are the innovators who

prefer brainstorming, metaphors, synthesizing, and holistic approaches to problem solving. They often have good communication skills and their thinking tends to be people-oriented, sensory, and kinesthetic, with awareness of feelings, values and personal relationships. Teachers, trainers, social workers and nurses often exhibit strong quadrant C preferences. As learners, these thinkers are good listeners, learn through sensory input, enjoy hands-on learning, and are respectful of other rights and views of others.

Quadrant D thinkers are often humanitarians who prefer to cooperative learning and group discussion. They are often visual, imaginative, spatial, flexible, and intuitive. Quadrant D thinkers often deal with possibilities, innovations and strategic planning. Entrepreneurs, artists, playwrights, scientists involved in research and development in medicine, physics, and engineering often display strong quadrant D preferences. As learners these thinkers look for the big picture rather than the details. They prefer pictures to words and doing open-ended problems (Lumsdaine, 1999).

The Gregorc Style Delineator

Most of us accept that the world is full of unique individuals. As early as 1970, Anthony Gregorc (2000), a teacher, school administrator and professor of education, was working on an assessment tool as "... a means of addressing the question of how, why, and what individuals can, will, and do learn."

As a result of his early research, The Gregorc Style Delineator was developed in 1982. The Gregorc Style Delineator is a self-analysis tool that identifies an individual's "mediation abilities" or the channels used to receive and express information. The outward appearance of one's "mediation abilities" is the individual's "style" (Gregorc, 1982). The Style Delineator is designed specifically for adults and a version for children is not available.

Through extensive research interviews, Gregorc (2000) identified four channels of mediation that individuals use for perception and ordering. These "channels" serve as the "frames of reference" which influence the individual's experience and resulting behavior. The Phenomenology research method was used to classify overt behav-

iors (phenos) and match them with underlying causes (noumena) in order to draw conclusions about the nature (logos) of the individual's style.

Assessment

The Gregorc Style Delineator is used to determine a person's style by assessing two types of mediation abilities: perception and ordering. Perceptual ability is determined by two qualities: abstractness and concreteness. Whereas the qualities that control one's ordering abilities are sequence and randomness. Each mind has all four of these qualities, but we use them with different intensity. The channels defined by Gregorc (2000) couple these qualities to determine the person's "qualitative orientation to life."

Learning Style Indicators

The four channels determined by Gregorc are: (1) concrete/sequential, (2) abstract/sequential, (3) abstract/random, and (4) concrete/random. The evaluation instrument is used to determine a person's most dominant mediation qualities. The individual can then analyze the characteristics associated with a particular style and perform a self-study to better understand the characteristics that influence his/her behavior or style (Gregorc, 2000).

The *concrete/sequential* learner is product-oriented, not people-oriented, and can be characterized as ordered and objective (Gregorc, 1984). An individual strong in this category learns in an orderly, step-by-step way and prefer hands-on activities (Butler, 1993).

The *abstract/sequential* learner is evaluative, logical and rational. This type of learner prefers reading and analysis, lectures and discussions (Butler, 1993).

The *abstract/random* learner is people-oriented, not product-oriented, and can be characterized as lively and spontaneous (Gregorc, 1984). Individuals in this category prefer to focus on themes, ideas, feelings and activities that allow for group interaction and communication (Butler, 1993).

The *concrete/random* learner is perceptive and likes to experiment and take risks (Gregorc, 1984). As learners, they prefer experimentation and problem-solving approaches to learning and like activities which encourage active investigations and applications (Butler, 1993).

Additional Learning Style Strategies and Assessments

There are other learning style strategies and assessments other than the Myers Briggs Type Indicator that students can use to discover their optimal learning style. The Memletics learning styles inventory is an online questionnaire and assessment that is free and comes with graphical assessment results (Memletics.com, 2003).

Working Style Analysis (WSA) is a learning style assessment used to profile the strengths and weaknesses of personal working styles (Creative Learning Company, 2004). This assessment tool can benefit the student and the faculty member, as well as be applied to an industrial setting.

The WSA, which is a fully computerized, online, self-assessment tool, is derived from research and findings of the PEPS, a personal assessment tool from the 1970s and the Learning Style Analysis (LSA) instrument created in 1994.

One of the perspectives of the assessment instrument is the evaluation of the teacher's optimal teaching style, whether it is traditional/analytic, flexible/adaptable, or individualistic/holistic. The teacher assessment displays the teacher's brain dominance, as well as the personal characteristics of the teacher in levels of persistence, conformity, responsibility, diversity awareness, classroom routines, need for variety, creativity and motivation. The fourth assessment graph depicts the teacher's success rate with particular type of students.

The WSA is also designed for employees to improve their performance in their careers. The graphical elements of the assessment evaluate the analytic (left-brain) versus the holistic (right-brain) biologically-based elements in specifically brain dominance processing and thinking style, sensory modalities, physical needs for optimal learning to take place, and environment preferred for optimal performance. Another set of graphs display conditioned and learned elements, both analytic and holistic, specifically social preferences in working groups and authority, as well as attitudes about motivation, persistence, conformity, responsibility, structure and variety.

The third graph displays any conflict between the way one is required to work at his or her job and the way one functions best. This conflict is what causes stress, lack of motivation, and dis-

satisfaction with the job. The interesting part of this assessment is that teams can be assessed and action plans are available.

Other learning style profiles have been developed for industry managers and trainers. The Learning Type Measure (LTM) is one of the most widely used tools used to profile learning styles of staff. It is a 26-point self report questionnaire that measures individual learning preferences (LTM, 2004).

How Technology Can Play a Pivotal Role

Many analysts advocate that technology is a social construct. Unequivocally, this means it is based on social and organizational choices, and people have the power to shape technology into what they want it to be. Those analysts, who advocate "sociotechnology," believe that society frames technology and technology in turn frames society. They believe that social factors play a major role in determining which new technologies become accepted in the higher education culture and society at large (Bunge, 2003).

Because of the adoption of technology into higher education, the expectation levels of teaching and learning have changed. Professors are expected to teach better, faster, and provide more information. Because of technology, students have access to virtual libraries and many other online resources, not only at school, but at home on their computer. This information era with high-speed broadband, e-mail, and online courses that can also be a supplement to face-to-face teaching, creates a higher education culture of instant gratification, as well as multimedia edutainment. Can the traditional university lecture survive this cultural change? Does technology enhance the teaching and learning process?

In 2003 a White Paper was released that confirmed that "blended learning" — incorporating online and e-learning options in traditional face-to-face courses resulted in a faster learning of application skills (Thomson and NETg, 2003). There is a marked improvement in student engagement and course satisfaction, and student learning is increased when online courses are added as a supplement to face-to-face traditional courses (DeLacey & Leonard, 2002). Providing alternative links for learners on an online page increases

learning as well (Dean, et al, 2001). Learning in the form of live face-to-face, along with virtual collaboration that includes synchronous and asynchronous, self-paced, and performance-supported activities constitutes a blended approach to learning (Rossett, et. al, 2004). Further studies on how technology affects learning styles of graphics students will be conducted at Arizona State University.

Conclusion

Being aware of and experimenting with diverse learning style models, teaching approaches and assessment instrumentation, is a continuing challenge for university graphics educators. How new technology plays a pivotal role in university graphics teaching and learning, is another challenge. Because of the adoption of technology in the academe, engineering and technology professions, and society as a whole, the way students learn and consequently, the way we must teach has changed. Through the review of learning style research we find several models and assessment instruments that can be applied to university graphics education. Many of these have been adapted as online tests. Future research needs to be done specifically on the learning styles of graphics students and the impact of technology for an optimal learning and teaching experience.

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Appendix

LEARNING STYLE MODELS

Displayed are five learning style assessment tools discussed in the article.

MYERS BRIGGS

TYPE INDICATOR (MBTI)

Based on Bloom's Taxonomy

Combinations of four preferences:

- (1) extraversion versus introversion,
- (2) sensing versus intuition,
- (3) thinking versus feeling, and
- (4) judging versus perceptive.

**MYERS BRIGGS
TYPE
INDICATOR**

**KOLB
LEARNING STYLE
INVENTORY**

KOLB

**LEARNING STYLE
INVENTORY**

Based on a four-stage learning theory.

Kolb summarized four different learning styles:

- (1) converger,
- (2) diverger,
- (3) assimilator, and
- (4) accommodator

**LEARNING
STYLE
MODELS**

**GREGORC
STYLE
DELINEATOR**

**HERRMAN
BRAIN
DOMINANCE
INSTRUMENT**

GREGORC

STYLE DELINEATOR

Based on assessing mediation abilities.

Gregorc's perception and ordering categories are:

- (1) concrete/sequential,
- (2) abstract/sequential,
- (3) abstract/random, and
- (4) concrete/random.

**GAGNE
LEARNING STYLE
INDICATOR**

GAGNE

LEARNING STYLE INDICATOR

Based on learning taking place through attention, encoding, and retrieval of information.

Gagné examines five major categories of learning that he identifies as:

- (1) verbal, such as learning an English word,
- (2) intellectual skills, such as learning a math formula,
- (3) cognitive strategy or logical reasoning,
- (4) attitude, and
- (5) motor skills.

HERRMAN

**BRAIN DOMINANCE
INSTRUMENT (HBTI)**

Based on thinking preferences.

Herrmann may be characterized as:

- (1) A-logical,
- (2) B-organized,
- (3) C-interpersonal, and
- (4) D-imaginative.