

Learning Styles: From History to Future Research

Implications for Distance Learning

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Abstract

The literature on learning styles offers a wide and confusing array of concepts. Despite that, experimental studies confirm their influence on learners' attitudes, values, degree of social interaction, and way of processing information, affecting academic performance. In consequence, learning styles research has, increasingly, been used as the theoretical foundation for the development of learning materials and Distance Learning Environments. The field, however, would benefit from both the systematization of the concepts available, and from their further investigation, since, from the plethora of models available for categorizing learning styles, only a few have been well validated. This paper reviews the literature on learning styles, systematizing the findings, pointing at the major unsolved problems and giving suggestions for future research.

Keywords

Learning styles, cognitive styles, learning preferences, learning strategies

Resumo

A literatura sobre estilos de aprendizagem oferece um amplo e confuso espectro de conceitos. Apesar disso, estudos experimentais confirmam sua influência nas atitudes, valores, grau de interação social, e forma de processamento da informação dos aprendentes, afetando o desempenho acadêmico. Em consequência, a pesquisa sobre estilos de aprendizagem tem, crescentemente, sido utilizada como embasamento teórico para o desenvolvimento de materiais pedagógicos e de ambientes virtuais de

aprendizagem. O campo, contudo, beneficiaria-se tanto da sistematização dos conceitos disponíveis como da maior investigação dos mesmos, dado que, da variedade de modelos existentes para categorizar estilos de aprendizagem, poucos foram devidamente validados. O presente estudo revê a pesquisa sobre estilos de aprendizagem, sistematizando suas descobertas, apontando os maiores problemas que todavia necessitam de solução e dando sugestões para pesquisas futuras.

Palavras-Chave

Estilos de aprendizagem, estilos cognitivos, preferências de aprendizagem, estratégias de aprendizagem

Reseña

La literatura en estilos de aprendizagem ofrece un espectro amplio y confuso de conceptos. A pesar de ésa, los estudios experimentales confirman su influencia en las actitudes, los valores, el grado de interacción social, y la manera de los principiantes de procesar la información, afectando lo funcionamiento académico. En consecuencia, la investigación de los estilos de aprendizaje, se ha utilizado cada vez más como la fundación teórica para el desarrollo de materiales y de ambientes virtuales de aprendizaje. El campo, sin embargo, beneficiaría de ambos la sistematización de los conceptos disponibles, y de su investigación posterior, puesto que, de la plétora de modelos disponibles para categorizar estilos de aprendizaje, sólo algunos se han validado bien. Este papel repasa la literatura en estilos de aprendizaje, sistematizando los resultados, señalando los problemas sin resolver principales y dando las sugerencias para la investigación futura.

Palabras-Clave

Estilos de aprendizagem, estilos cognitivos, preferencias de aprendizagem, estrategias de aprendizagem

1. Introduction

Human beings were born to learn, it is a natural instinct. Foreign language, math, science, it does not matter: all, except those with severe brain damage, are able to learn the various subjects, including learning-disabled persons. However, even though every student within a group can learn, they do not, necessarily, learn in the same way.

An enduring and fundamental question within the educational research field relates to the effect of individual differences on the efficacy and efficiency of learning. Some of the aspects that have been explored largely refer to differences in learning styles. Research has shown, for example, that the quality of learning material is improved if it is designed to take into account differences in learning styles (McLoughlin, 1999; Rasmussen, 1998; Riding & Grimley, 1999).

And regarding distance learning, the rule is the same. Whenever information is presented in ways that are congruent with the students preferred styles, their academic achievements are increased and more positive attitudes toward learning are developed. In this way, the challenge for designers of Virtual and Adaptive Learning Environments, as well as on-line courses, goes beyond catering for diversity. It refers to the acquisition of knowledge regarding individuals' different learning needs, and the integration and connection of that with the design process.

This paper is divided into five main sections, including this introduction: literature review, conclusion, references, and acknowledgements. The following section reviews the literature on learning styles.

2. Literature Review

The word review means to go over again. This section is both a compilation and a critical review of the literature on learning styles, and it is divided into four sub-sections: Learning Styles – A bit of history, Learning Styles – Influence on learning performance, Learning Styles – Definitions and terminology, and Learning Styles – Conflicts and Strategies.

2.1 *Learning Styles: A Bit of History*

So, all students can learn. In reality, students can learn from many different modes and types of exposure. What is different from one individual to another, nevertheless, is how each prefers to learn, understanding learning as a change, whether in relation to behavior, attitudes, values or competencies (Pinto, 1992).

The idea that people learn differently, though, is not at all new. Its origin probably dates back to the ancient Greeks (Wratcher, Morrison, Riley & Scheirton, 1997; Diaz & Cartnal, 1999). Experimental studies in differential psychology have shown that individual differences play an important role in learning and instruction (Jonassen & Grabowski, 1993). For many years, educators have noticed that some students prefer certain methods of learning to others. These dispositions form a student's unique learning preferences, and are referred to as learning styles (Kemp, Morrison & Ross, 1998).

The research on learning styles started in the first half of the 20th century. But the term style was probably first used by the Greek physician Hippocrates, who identified different types of personalities. In 1945, a distinction between visual and haptic types was reported by Lowenfeld, referring to individuals who experience the world primarily through vision or touch (Guild & Garger, 1998). In 1960, Kolb introduced the term learning styles to educational vocabulary. Around the same period, Witkin introduced the term cognitive style (Rumetshofer & Wöß, 2003). Even today, however, there is no overall theory, only a plethora of models and instruments for

categorizing learning styles, ranging from brain dominance to types of cognitive styles. Thus, the vast learning styles literature remains an unreliable source. As Vincent & Ross (2001) and Suskie (2002) note, professional educators are unable to form consensus regarding the establishment of a single set of accepted principles. Additionally, critics point out that for a learning style theory to be valid and useful, it must prove that students learn more effectively when their learning styles are accommodated. Bonham (1988), Kavale & Forness (1987), and Rayner & Riding (1997) consider that the usefulness or validity of learning style models and instruments has not been definitively established. A particular concern is that most learning style theories label students into a few discrete, quantitative, and often dichotomous categories, instead of recognizing that individuals develop and practice a qualitative mixture of learning styles, which changes over time and varies according to discipline (Grasha, 1990; Stellwagen, 2001; Silver, Strong & Perini, 1997; Suskie, 2002). Another issue refers to the effect of cultural differences in learning styles (Swanson, 1995).

In conclusion, the field of learners' differences is disorganized, the research has declined in recent years (Schunk, 2004), and terms are often poorly defined. All that makes attempts to draw conclusions difficult.

2.2. *Learning Styles: Influence on Learning Performance*

Despite all that has been stated, based on empirical research, there is evidence that individual differences in learning styles can affect performance in learning settings, signaling that learning styles can hinder or enhance academic performance (Riding & Grimley, 1999; Richardson, 1994). Rumetshofer & Wöß (2003) affirm that it influences attitudes, values, degree of social interaction, and the way a person processes information. A meta-analysis of forty-two experimental studies conducted with the Dunn and Dunn model between 1980 and 1990 by thirteen different institutions of higher education revealed that students whose characteristics

were accommodated by educational interventions responsive to their learning styles could be expected to achieve 75 percent of a standard deviation higher than students whose styles were not accommodated (Dunn, Griggs, Olson, Gorman, & Beasley, 1995). According to Piombo, Batatia and Ayache (2003), matching instruction to learning style allows the student to retain information longer and apply it more effectively. Cognitive strategies, once embedded inside the learning program, not only allow students to perform better than those without learning strategies, but also to retain these strategies after two months (Thornburg & Pea, 1991). And in relation to the quality of learning material, according to McLoughlin (1999), Rasmussen (1998), and Riding & Grimley (1999), research supports that it is improved if designed to take into account differences in learning styles. Schunk (2004) considers that the amount of research on the field is sufficient to guide future efforts and attempts to apply findings to improve students' adaptive functioning.

According to Curry (1987), learning styles make intuitive sense. For instance, it is apparent that some students prefer reading books rather than listening to them on tape and vice versa, or that some students prefer working alone rather than working with others and vice versa. Indeed, some learning preferences, like the preference for a quiet background, seem so self evident that a validated instrument may not be necessary to access them (Suskie, 2002).

Styles are inferred from consistent individual differences in organizing and processing information on different tasks, to the extent that styles affect cognition and behavior, and help link cognitive, affective and social functioning. In return, stylistic differences are associated with differences in learning, as well as receptivity to various forms of instruction (Messick, 1984,1994). Differences in learning styles are a result of such things as past and present life experiences, genetic make-up, educational experiences, and the demands of the present environment (Manner, 2001; Kolb, 1984; Dunn, 1990, 1993).

Care should be taken in selecting literature on learning styles, for research has focused on different aspects of this complex. In this way, while affirming that learning styles can improve academic performance, one should verify which types of learning styles are under discussion. A number of styles have been investigated in more depth, and there is more research evidence on their importance. On the other hand, some of the identified styles are not backed up with scientific data, or are found in the literature labelled in a confusing way. For example, the concepts of field-dependence and field-independence have been thoroughly investigated. Witkin began his work on perception in the late 1940s and continued it until his death in 1979 (Guild & Garger, 1998). Together with Moore, Goodenough and Cox, Herman A. Witkin (1977) proposed the existence of different perceptual tendencies in persons depending on how they view and use their surroundings. They developed tests designed to determine reliance on cues received from the background field. Those perceptual distinctions, known as field-dependence and field-independence, refer to the ability to distinguish key elements from a distracting or confusing background.

On the other hand, some of the cognitive preference concepts -such as holistic, i.e. individuals tending to see a situation as a whole - are sometimes named differently, like synthetic. And many times, they do not even mean the exact same thing. Other terms, like analytical for example, are used by different authors with different meanings. In this way, learning styles literature can be very informative or confusing, depending on the sources selected.

2.3. *Learning Styles: Definitions and Terminology*

Definitions of learning styles vary. A commonly used one was proposed by Keefe (1979): “Learning Styles are characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment” (p.4). Another usual definition explains learning style as a consistent or habitual

mode of acquiring or imparting knowledge through study, experience or teaching (Beishuizen & Stoutjesdijk, 1999). Messick (1994) defines learning styles as “modes of perceiving, remembering, thinking, problem solving, and decision making, reflective of information-processing regularities that develop in congenial ways around underlying personality trends” (p.122).

As mentioned earlier, many terms in the learning styles literature are, sometimes, used interchangeably, like learning styles and cognitive styles. In order to try to distinguish concepts that are similar and yet quite distinctive, McLoughlin (1999), Curry (1991), and Riding & Cheema (1991), organized the main concepts according to the degree to which they can be observed and articulated, providing a group of definitions and classifications (Table 1).

In the Learning Styles literature, there appears to be two major threads of research (Leaver, 1997; Dorwick, 2004). The descriptive approach notes that both teachers and students learn things in different ways and focus on providing information about learner differences, not on preformatted lessons plans. The prescriptive thread, on the other hand, not only notes the differences, but also recommends that teachers overtly design their teaching activities to address one or other dimension of the various criteria for differing styles, and, in this way, dictate classroom practices. Within these two traditions, a variety of labels are found, relating to distinct dimensions of leaning styles. According to Dunn (1993), learning modes have different characteristics; nevertheless, they tend to overlap in many respects.

Felder and Silverman (1988) explain learning styles in reference to input preference (sensory/intuitive), sensory modality (visual/verbal), information organization (inductive/deductive), information processing (actively/reflectively), and understanding progress (sequential/global).

Table 1: Definition of Learning Styles related terms.

TERM	EXPLANATION
Learning Preferences	Favoring one method of teaching over another
Learning Strategy	Adopting a plan of action in the acquisition of knowledge, skills or attitudes
Learning Style	Adopting a habitual and distinct mode of acquiring knowledge
Cognitive Strategy	Adopting a plan of action in the process of organizing and processing information
Cognitive Style	A systematic and habitual mode of organizing and processing information

Riding & Cheema (1991) affirm that learners differ in terms of two fundamental dimensions: the way they process information and the way they represent information during recall. They describe the different aspects of cognitive styles as a continuum, in opposition to dichotomous categories, and as independent of the other.

Gregorc (1985a) and Butler (1988) use a theory that identifies learning style in terms of the following modes: concrete, abstract, sequential and random.

Sousa (1995, 1997, 1999) identifies three primary differences in learning styles: auditory, visual and kinesthetic. Fleming (1995b) has further modified these three sensory preferences, specially the visual sense, by disaggregating its components into visual information presented as text – a read/write preference, from pictures such as diagrams and video, a visual preference.

Leaver (1997) has clustered learning differences into four overarching categories (Table 2): sensorial modalities, cognitive styles, personality types and environmental preferences, making easier the task of understanding the various existing systems, once they are grouped by type. These four categories are subdivided further and explained on Tables 3a, 3b (Leaver, 1997; Jensen, 1998), 3c (Leaver, 1997; Myers & Briggs, 1976) and 3d (Leaver, 1997; Jensen, 1998).

Table 2: Definition of the main categories related to Learning Styles

SENSORIAL MODALITIES DEFINITION	COGNITIVE STYLES DEFINITION	PERSONALITY TYPES DEFINITION	ENVIRONMENTAL PREFERENCES DEFINITION
Students perceive new information	The ways in which people	The manner through which	The physical environment where

Table 2 (continued): Definition of the main categories related to Learning Styles

SENSORIAL MODALITIES DEFINITION	COGNITIVE STYLES DEFINITION	PERSONALITY TYPES DEFINITION	ENVIRONMENTAL PREFERENCES DEFINITION
Students perceive new information through different physical channels. Among the most common sensorial modalities are:	perceive and process information affect how they learn. Among the most common processing systems are:	learners relate to one another and with the physical and intellectual world around them have an influence on their learning process. Some of	the learner is situated and the physiological conditions, like biorhythm, digestion and atmosphere, influence student learning.

visual (verbalist/ imagist), auditory (aural/ oral) and motor (mechanical/ kinesthetic).	global/ particular differences, leveling/ sharpening differences, inductive/ deductive differences, synthetic/ analytical	the most known factors are: introversion/ extroversion, sensing/ intuitive, thinking/ feeling, judging/
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Table 2 (continued): Definition of the main categories related to Learning Styles

SENSORIAL MODALITIES DEFINITION	COGNITIVE STYLES DEFINITION	PERSONALITY TYPES DEFINITION	ENVIRONMENTAL PREFERENCES DEFINITION
	differences, concrete/ abstract differences, impulsive/ reflexive differences, sequential/	perceiving. Once combined, they produce different personality types.	

random
differences, and
field dependent/
field independent
differences.

Sensorial modalities are related to the different physical channels through which students perceive and take in new information. According to Leaver (1997), most individuals have a primary modality and a secondary modality through which they learn. Some even have a tertiary modality, but that is more rare. A few individuals have no preference – all modalities work for them. Fleming (1995a) proposes that individuals can either be uni-modal, bi-modal, tri-modal or multi-modal.

The ways in which people perceive and process information effects how they learn. Cognitive styles concern the thinking processes, a complex set of actions that takes place in the mind. In order to think, intake or recall of information must first occur, followed by processing, storage and reconstruction of that information, as well as generation of unique thought. Cognitive styles bear on the how, on the manner in which behavior occurs, with emphasis upon process.

Table 3a: Learning Styles Subcategories explained

SENSORIAL MODALITIES

1. Visual Learners	1.a. Visual Verbalists
Important visual distinctions: color, shape, size, brightness, contrast, saturation, distance, clarity, texture, frame and symmetry.	They see words. Ex.: If they want to remember the French word for sun, they will see the letters <i>soleil</i> in their heads.
Visual information is processed and stored in the occipital lobe at the back of the brain.	1.b. Visual Imagists They see pictures. Ex.: If they want to remember the French word for sun, they will associate it with an image of the sun.

Table 3a (continued): Learning Styles Subcategories explained

SENSORIAL MODALITIES

2. Auditory Learners	2.a. Auditory Aural
Important sound distinctions: pitch, tempo, volume, rhythm, timbre and resonance.	They learn by listening to others.
Information that is auditory is processed and stored in the temporal lobes on the sides of the brain.	2.b. Auditory Oral They learn by talking and hearing themselves.
3. Motor Learners	3.a. Motor Kinesthetic
Important movement distinctions: frequency, pressure, duration, intensity,	They learn through the use of gross motor muscles.

speed and direction.	3.b. Motor Mechanical
Motor information is stored at the top of the brain in the motor cortex until permanently learned; then it is stored in the cerebellum, the area below the occipital lobe.	They learn through the use of fine motor muscles . Ex.: A motor learner is someone who learns telephone numbers by dialing them. Often, motor learners cannot tell someone else the number without picking up an imaginary phone and pretending to dial.

Table 3b: Learning Styles Subcategories explained

COGNITIVE STYLES

1. Global vs. Particular Differences	Grasps big picture vs. details.
2. Leveling vs. Sharpening Differences	Notices first similarities vs. differences.
3. Synthetic vs. Analytic Differences	Uses pieces to build new wholes vs. breaks wholes into parts and sees that the big picture is composed of small pieces.

4. Impulsive vs. Reflective Differences	Thinks and responds nearly simultaneously, i.e. very fast, but has problems with accuracy vs. first thinks and then responds, that is, often needs extra time to finish work, so can think over and over, and produce better results.
5. Inductive vs. Deductive Differences	Works from examples to rules vs. from rules to examples.

Table 3b (continued): Learning Styles Subcategories explained

COGNITIVE STYLES

6. Concrete vs. Abstract Differences	Learns best with real materials and examples, needs to try things out and is able to formulate real-life examples vs. need lectures, books and films, and is able to formulate theoretical, symbolic models very well.
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7. Sequential vs. Random Differences	Feels lost without external organization, has an organized bedroom and does one project at a time vs. has own internal order that may not seem so organized to many people and for that reason is often called messy, and does many projects at a time.
8. Field Dependence vs. Field Independence Differences	Needs vs. does not need structure for effective learning.
9. Divergers vs. Assimilators vs. Convergents vs. Accommodators (Kolb's Learning Styles	A Diverger needs pre-activity work, such as demonstration and discussion, and small group

Table 3b (continued): Learning Styles Subcategories explained

COGNITIVE STYLES

Topology)	interaction, i.e. needs to experience subject matter and to observe others at work in order to learn best. An assimilator needs clear rules and detailed information, and is not comfortable taking risks. A converger needs to know “How” and to have hands on practice. An accommodator learns from trial and error, and needs independence in learning .
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Table 3c: Learning Styles Subcategories explained

PERSONALITY TYPES: JUNG TYPOLOGY

1. Introversión vs. Extroversión	Looses energy in interaction with large numbers of people vs. gains energy from interaction with people.
2. Sensing vs. Intuitive	Needs hard evidence vs. works with intuition.
3. Thinking vs. Feeling	Places principles over people vs. people over principles.

Table 3c(continued): Learning Styles Subcategories explained

PERSONALITY TYPES: JUNG TYPOLOGY

4. Judging vs. Perceiving	Focuses on quickly completing the task, only wants to know the essentials vs. starts too many tasks, wants to know everything about each one and has difficulty in completing them.
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Table 3d: Learning Styles Subcategories explained

ENVIRONMENTAL PREFERENCES

1. Preferences regarding sound	Ex.: Studies with music background or silence.
2. Preferences regarding lighting	Ex.: Studies with spotlight or diffuse light.
3. Preferences regarding posture	Ex.: Studies sitting down or lying down.
4. Preferences regarding study time	Ex. : Likes morning or evening better.
5. Preferences regarding digestion	Ex.: Likes to study with a full or empty stomach.
6. Preferences regarding temperature	Ex.: Feels more comfortable warm or cold.
7. Preferences regarding grouping	Ex.: Likes to study alone or in group.

Table 3d(continued): Learning Styles Subcategories explained

ENVIRONMENTAL PREFERENCES

8. Preferences regarding mobility	Ex.: Likes to study sitting still or moving around.
9. Preferences regarding manipulation	Ex.: Plays with a pen while studying or remains still.

Personality Types involve the ways in which learners relate to other people and to the physical and intellectual world around them, and the influence of that on their learning.

Environmental Preference regards the aspects of the physical surroundings and physiological conditions that have an influence on students' learning process.

2.4 Learning Styles: Conflicts and Strategies

Difficulties in learning arise when a student has a strong preference in one modality and is required to learn through a different one. Visual learners, for example, often have poor performance on oral tests due to a difficulty in converting their visual memory of the facts into auditory memory. Aural learners need auditory input; when they read instructions, they often become lost. Oral learners, on the other hand, need auditory output; as children, they, often, cannot keep quiet and tell whatever is going on their minds.

According to Dunn (1993) and Fleming (1995a, 1995b), preferences for learning styles change over time. However, during the period in which an individual has strong style preferences, that person will achieve most easily when taught with strategies and resources that complement those preferences.

Student-teacher or student-peer style incompatibilities or conflicts, known as style conflicts, can bring unfortunate effects to learning. Gregorc (1985a, 1985b) advises the consideration of both style match and clash between teacher and learners. Felder & Henriques (1995), Godleski (1984), Oxford, Ehrman & Lavine (1991), and Schemeck (1988) affirm that students, in those

situations, tend to: be bored and inattentive in class, perform poorly on tests, get discouraged about the course and, perhaps, conclude that they are no good at the subject and give up.

Developing style flexibility in students seems the most empowering path, and making them style aware too (Zapalska & Dabb, 2002; Leaver, 1997). Learning style versatility can be achieved by exposing students to a variety of learning experiences. In this way, they can be better prepared for the real world and life-learning process. The methods used to help students understand how they learn should, however, be kept brief and simple, so they are not distracted from the goals and objectives of the class. Together with the identification of their learning styles, learning strategies can be examined within the context of their learning experiences and the extent to which each can succeed or fail in aiding them in their learning process.

Learning strategies are cognitive plans oriented toward successful task performance (Shunk, 2004; Pressley, Woloshyn, Lysynchuck, Martin, Wood & Willoughby, 1990; Weinstein & Mayer, 1986). According to Leaver (1997), they are specific techniques used to acquire new information. Schunk (2004) affirms that strategies include activities such as selecting and organizing information, rehearsing material to be learned, relating new material to information in memory, and enhancing meaningfulness of material. Also included are techniques that create and maintain a positive learning climate. The four-category system for grouping learning strategies (Oxford, 1990; Poulisse, 1989; Poulisse, Bongaerts & Kellerman, 1984; Leaver, 1997) was adopted here. It includes metacognitive strategies, cognitive strategies (including memorization and coping strategies), social strategies and affective strategies. Metacognitive strategies are associated with thinking about one's own learning process, and include: advanced organization, monitoring, homework planning, selective attention, evaluation, setting goals, self-awareness, anticipation and selecting tasks. Cognitive strategies are associated with the details of the thinking process. The list is vast, and includes, among many other variables: elaboration, context

expansion, habit extension, clustering, categorization, hypothesis formation, hypothesis confirmation, grapheme and phoneme conversion, rehearsing, applying the known, recombination, recognition, looking for patterns, comparison, paraphrasing, assembly, disassembly, information location, sequencing, and structuring. Social strategies relate to interaction with others, and include: questioning, listening, cooperating, negotiating, getting involved, and empathizing. Affective strategies relate to one's emotional state, and include: risk taking, self-talking, keeping a diary, discussing, relaxing deliberately, laughing, thinking positively, self-reinforcing, taking charge, and culturally accepting.

For the use of strategies, an important issue is self-knowledge. Gregorc (1982, 1985a, 1985b) is one of the authors that investigated the topic in depth. He designed ways for people—especially adults, teachers, and administrators—to understand their own styles and to bring that knowledge to their interactions with students who would inevitably be both similar and different in style.

Trying to associate learning styles to a particular human learning theory is not trivial. More recent research has investigated the organization of styles within information processing frameworks and within the structure of human personality (Messick, 1994; Sternberg & Grigorenko, 1997). Information processing, though, is not the name of a single theory, but the generic term applied to theoretical perspectives dealing with the sequence and execution of cognitive events (Schunk, 2004). Common criticism of information processing theories refers to the fact that they try to explain learning processes, sometimes vaguely, other times failing to address important issues, and, most of all, without considering the reasons for which those processes occur. Learning styles also fail to explain the reasons behind learning differences. The following section presents the conclusion and suggests future steps.

3. Conclusion

The research on learning styles started in the first half of the 20th century and, until today, attracted the attention of scientists from different fields, receiving more or less status in different time periods. The variety of concepts found on learning styles literature makes it, nevertheless, difficult to build a unified framework. The best effort to systematize learning differences was provided by Leaver (1997), who clustered the major concepts into four overarching categories: sensorial modalities, cognitive styles, personality types and environmental preferences, making it easier to understand the various existing systems. In relation to problems regarding poor definition of terms, sometimes used interchangeably, McLoughlin (1999), Curry (1991), and Riding & Cheema (1991), provided the most clear and organized classification of the main concepts, such as learning preferences, learning style and cognitive style, differentiated according to the degree to which they can be observed and articulated.

Literature on style differences should be selected with care, since research has focused on different aspects of learning styles. A number of learning styles have been investigated in more depth, while others are not backed up with scientific data.

Based on empirical research, there is actual evidence that individual differences in learning styles can affect performance in learning settings. Further research, however, needs to be done in order to better understand different aspects of this complex and to build a cohesive theoretical base. Schunk (2004) considers, however, that the amount of research on the field is sufficient to guide future investigations, and to apply findings to improve students' adaptive functioning. Efforts should be directed towards learners' empowerment through the development of style flexibility and awareness, as well as use of a set of learning strategies, aiming at successful task performance.

Among the major unsolved problems in the field are the lack of: an overall theory, consensus regarding the establishment of a set of accepted principles, and acceptable proof that students can learn more effectively when their learning styles are accommodated.

Despite this, learning styles research offers a rich area for extracting insights, which have potential to help improve the design of Virtual Learning Environments and Adaptive Learning Systems, as well as the design of any other learning system or media. Existing Virtual Learning Environments and Adaptive e-Learning Systems, for instance, frequently fail to deal with the underlying issues, such as learner characteristics and needs, and the influence of media upon the instructional and learning processes. In this way, in order to transform the promise of Adaptive Learning Systems into real individualized learning, a solid understanding of the learner's cognitive habits is essential.

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