Learning Styles: An overview of theories, models, and measures

Simon Cassidy[*]
University of Salford, UK

Although its origins have been traced back much further, research in the area of learning style has been active for—at a conservative estimate—around four decades. During that period the intensity of activity has varied, with recent years seeing a particularly marked upturn in the number of researchers working in the area. Also of note is the variety of disciplines from which the research is emerging. Increasingly, research in the area of learning style is being conducted in domains outside psychology—the discipline from which many of the central concepts and theories originate. These domains include medical and health care training, management, industry, vocational training and a vast range of settings and levels in the field of education. It is of little wonder that applications of these concepts are so wide ranging given the centrality of learning—and how best to do it—to almost every aspect of life. As a consequence of the quantity of research, the diversity of the disciplines and domains in which the research is conducted, and the varied aims of the research, the topic has become fragmented and disparate. This is almost certainly how it must appear to practitioners and researchers new to the area, with its complexities and convolutions difficult to comprehend and assimilate. As such, it is perhaps timely to present an account of the central themes and issues surrounding learning style and to consider the instruments available for the measurement of style. This paper aims to provide such an account, attempting to clarify common areas of ambiguity and in particular issues surrounding measurement and appropriate instruments. It aims to bring together necessary components of the area in such a way as to allow for a broader appreciation of learning style and to inform regarding possible tools for measurement. It is anticipated that such an account will promote research in the field by presenting it as more accessible and by developing a greater appreciation for the area across disciplines and in researchers and practitioners new to the area.

Introduction

For some time now educational research exploring the issue of academic achievement or success has extended—rightfully so—beyond "simple" issues of intelligence and prior academic achievement. There are a number of learning-related concepts, such as perception of academic control and achievement motivation which have been a focus of attention when attempting to identify factors affecting learning-related

*Directorate of Psychology, University of Salford, Allerton Building, Frederick Road, Salford M6 6PU, UK. Email: s.cassidy@salford.ac.uk

performance (Cassidy & Eachus, 2000). One concept in particular which has provided some valuable insights into learning in both academic and other settings is *learning style*. There is general acceptance that the manner in which individuals choose to or are inclined to approach a learning situation has an impact on performance and achievement of learning outcomes. Whilst—and perhaps because—learning style has been the focus of such a vast number of research and practitioner-based studies in the area, there exist a variety of definitions, theoretical positions, models, interpretations and measures of the construct. To some extent, this can be considered a natural consequence of extensive empirical investigation and is to be expected with any continually developing concept which proves useful in gaining understanding of such a crucial and prevailing endeavour as learning. However, the level of ambiguity and debate is such that even the task of selecting an appropriate instrument for investigation is an onerous one, with the unifying of subsequent findings within an existing framework problematic, at best. This paper does not seek to achieve an absolute resolve and converge upon the *ideal* model and measure of learning style, but rather to inform through description and comparison. It is intended as a resource for researchers and professionals who desire a broad appreciation of the area of learning style and who may, previously, have been working with an in-depth understanding but, perhaps, only a narrow awareness of the field. Riding and Cheema (1991) have previously noted that researchers in the field of cognitive style/learning style often present only a very limited (if any) account of the variety of theories and instruments which exist for the measurement of style.

Whilst educators in all fields are becoming increasingly aware of the critical importance of understanding how individuals learn, it is equally important that any attempts to integrate learning style into educational programmes are made from an informed position. John Yerxa, Education Officer with the Department of General Practice and the Adelaide to Outback GP Training Programme, comments: "Simply being aware that there can be different ways to approach teaching and learning can make a difference" (Yerxa, 2003). Whilst there may be some truth in such comments, they are not helpful in a drive towards research- and practitioner-based activity which exhibits good awareness of learning style theory and empirical evidence. This paper aims to provide an accessible overview of theories, instruments and empirical work in the field of learning style.

Key Terminology … And some fundamental issues

Defining the key terms in this area is not a straightforward task. The terms "learning style", "cognitive style" and "learning strategy" are—understandably—frequently used imprecisely in theoretical and empirical accounts of the topic. The terms learning style and cognitive style are, on some occasions, used interchangeably, whilst at other times they are afforded separate and distinct definitions. Cognitive style is described by Allport (1937) as an individual's typical or habitual mode of problem solving, thinking, perceiving and remembering, while the term learning style is adopted to reflect a concern with the application of cognitive style in a learning

situation (Riding & Cheema, 1991). Riding and Cheema (1991) go on to describe cognitive style in terms of a bipolar dimension (wholist–analytic) while learning style is seen as encompassing a number of components which are not mutually exclusive. It is also likely that cognitive style—at the very least—can be regarded as one significant component of learning style. Hartley (1998) provides the following definitions: cognitive styles are the ways in which different individuals characteristically approach different cognitive tasks; learning styles are the ways in which individuals character-istically approach different learning tasks. A third key term in the area, learning strategies, Hartley (1998) defines as the strategies students adopt when studying. Hartley (1998, p. 149) continues: "different strategies can be selected by learners to deal with different tasks. Learning styles might be more automatic than learning strategies which are optional." This final point, which attempts to distinguish between style and strategy, reflects a recurring issue in the area.

The "state-or-trait" debate associated with so many human psychological charac-teristics (such as personality) is, not surprisingly, relevant here. Learning style may be considered as stable over time (structural)—a trait—or as changing with each experience or situation (process)—a state. Perhaps the more workable view is that a style may well exist is some form, that is it may have structure, but that the structure is, to some degree, responsive to experiences and the demands of the situation (process) to allow change and to enable adaptive behaviour. The "motherboard/software" and "hard/soft" wiring analogies have also been used to describe the interface of style (motherboard/hard wiring) and strategy (software/soft wiring). Investigating the issue of stability in learning style Loo (1997) did find evidence to support consistency in learning style over time, but was critical of current techniques of analysis and recommended caution in drawing any firm conclusion regarding stability.

One final term worthy of definition here is "preferences". A number of authors refer to the favouring of one method of teaching over another (such as group work over independent-study) as learning preferences. The major preferences are fairly well integrated within a number of the models discussed and are often dealt with explicitly by the more elaborate models of learning style.

Characterising Learning Style: Simplifying matters

The preferred way in which an individual approaches a task or learning situation— their learning/cognitive style or approach or strategy—has been characterised in several different ways based on a variety of theoretical models. Before reviewing these models and characterisations, it may be helpful first to consider existing attempts at simplifying and categorising current systems along key dimensions (see Table 1).

Curry's Onion Model

Using the way in which learning/cognitive style is measured to propose a layer-like model of learning behaviour, Curry (1983, 1987) utilises an onion metaphor to illustrate inner and outer layers of the construct. Initially proposing three layers, Curry

Table 1. Taxonomy of learning style models

Model	Curry (1987)				Riding and Cheema (1991)	Rayner and Riding (1997)		
	Instructional preference	Social interaction	Information processing	Cognitive personality	Wholist–analytic	Personality centred	Cognitive centred	Learning centred
Witkin (1962) Field-dependence/independence				●	●		●	
Kagan (1965) Impulsivity–reflexivity				●	●		●	
Holzman and Klein (1954) Leveller–sharpener				●	●		●	
Pask (1972) Holist–serialist				●	●		●	
Pavio (1971) Verbaliser–visualiser				●			●	
Gregorc (1982) Style delineator				●	●		●	
Kauffmann (1979) Assimilator–explorer				●	●		●	
Kirton (1994) Adaption–innovation				●	●		●	
Allinson and Hayes (1996) Intuition–analysis				●	●		●	
Kolb (1984) ELM			●					●
Honey and Mumford (1992) LSQ			●					●
Vermunt (1994) LSI			●					●
Entwistle & Tait (1995) Surface–deep			●					●
Biggs et al. (2001) SPQ			●					●
Schmeck et al. (1991) ILP			●					●
Hunt, Butler, Noy, and Rosser (1978) Conceptual level			●					●
Dunn, Dunn, and Price (1989) LSI	●	●						●
Reichmann and Grasha (1974) Styles of learning interaction model	●	●						●
Ramirez and Castenada (1974) Child rating form	●	●		●				●
Reinert (1976) ELSIE				●				●
Hill (1976) Cognitive Style Interest Inventory				●				●
Letteri (1980) Learner types				●				●
Keefe and Monks (1986) Learning style profile	●	●		●				●

later includes "social interaction" as a fourth layer. "Instructional preference" refers to the individual's preferred choice of learning environment. It is described as the outermost layer, the most observable layer and the layer most susceptible to influence, making it the least stable level of measurement. Instruments cited as measuring instructional preference include the Learning Preference Inventory (Rezler & Rezmovic, 1981). Social interaction provides the next layer and relates to the individual's preference for social interaction during learning. Reichmann and Grasha's (1974) Student Learning Style Scale defines learners according to their type and level of interaction (independent/dependent, collaborative/competitive, and participant/avoidant). The third and more stable layer is "information processing style" and is described as the individual's intellectual approach to the processing of information. Instruments associated with the measurement of this layer are Kolb's Learning Style Inventory (Kolb, 1976), Cognitive Preference Inventory (Tamir & Cohen, 1980) and Inventory of Learning Processes (Schmeck, Ribich, & Ramaniah, 1977). The final layer described is "cognitive personality style". This appears the most robust component, described as a "relatively permanent personality dimension … apparent only when an individual's behaviour is observed across many different learning situations" (Riding & Cheema, 1991, p. 195). Associated instruments for measurement are the Embedded Figures Test (Witkin, 1962), Myers Briggs Type Indicator, (Myers, 1962) and Matching Familiar Figures Test (Kagan, 1965).

Riding and Cheema's Fundamental Dimensions

Having identified in excess of 30 labels used to describe a variety of cognitive and learning styles, Riding and Cheema (1991) propose a broad categorisation of style according to two fundamental dimensions representing the way in which information is processed and represented: wholist–analytic and verbaliser–imager.

The wholist–analytic dimension represents the manner in which individuals tend to process information, either as a whole (wholist) or broken down into components parts (analytic). Quoting Nickerson, Perkin, and Smith (1985), Riding and Cheema describe the wholist–analytic dimension using commonly associated terms: analytic—deductive, rigorous, constrained, convergent, formal, critical and synthetic; wholist—inductive, expansive, unconstrained, divergent, informal, diffuse and creative.

The verbaliser–imager dimension describes the degree to which individuals tend to represent information as words (verbaliser) or as images (imager).

They suggest a number of models of cognitive style which can be subsumed under these dimensions (or families). Table 1 includes examples of these family groupings along with the categorical frameworks proposed by Curry (1987) and Rayner and Riding (1997).

Riding and Cheema (1991) make the point that many of those styles identified do not feature heavily in empirical work and that attention has focused on only a small number of styles. They conclude that whilst there is relatively little research comparing the various styles, they can at least be placed into the two broad categories of wholist–analytic and verbal–imagery. The two fundamental cognitive styles exist

independently and are not contingent upon one another; an Imager may be positioned at either end of the wholist–analytic dimension. Riding (1991) has developed the Cognitive Styles Analysis (CSA) as an assessment tool integrating the two dimensions.

Cognitive-Centred, Activity(Learning)-Centred and Personality-Centred Approaches

Using Grigerenko and Sternberg's (1995) discussion of style-based theory and research, Rayner and Riding (1997) consider learning style within the framework of personality-centred, cognitive-centred and learning-centred approaches. There is only limited discussion of personality-centred approaches given, according to Rayner and Riding, its limited influence in the area and the existence of only a single model (Myers Briggs style model) which explicitly incorporates personality as a major factor.

Cognitive-centred approaches focus on the identification of styles based on individual difference in cognitive and perceptual functioning. The discussion of cognitive-centred approaches attempts to integrate the earlier work of Riding and Cheema (1991), categorising models according to wholist–analytic and verbal–imager principles. The discussion revisits models considered earlier by Riding and Cheema and extends to include a number of additional models including Riding's (1991) Cognitive Style Analysis (CSA). The CSA is a computerised assessment tool which identifies an individual's position along both the wholist–analytic dimension and the verbaliser–imager dimension. The CSA is an example of a model and instrument of learning style which incorporates the two proposed fundamental dimensions of style.

Learning-centred approaches are distinguished on the basis that there is a greater interest in the impact of style on learning in an educational setting, and the development of new learning-relevant constructs and concepts, often born out of the utilisation of assessment instruments. Rayner and Riding's subsequent discussion of learning-centred approaches is framed around the distinction between process-based models, preference-based models and cognitive skills-based models. Process models are defined in terms of perceiving and information processing, with Kolb's Experiential Learning Model representing one such approach. Preference models focus on individuals' preferences for the learning situation and include preferred time of day for study, temperature, light, preference for group/independent study. Cognitive skills-based approaches are characterised by the desire to apply cognitive-centred models of style to a learning situation. These approaches focus on field-dependency, perceptual modality and memory.

Further reviews are provided by De Bello (1990) and Swanson (1995). De Bello provides a systematic review of 11 of what he considers "major models", selected according to the following criteria: represent a historical perspective; have influenced others; reflect individual practitioners' attempts to identify style; relate to concurrent issues in education; are research oriented; or are widely known in the field. De Bello presents a comprehensive account of those models reviewed with an evaluative component, making this a useful guide for the selection of appropriate models for work in the area. Swanson's review uses Curry's onion model as a framework for

categorising models and measures according to the outlined component layers of learning style. Swanson's article also provides a relatively rare review of the effects of culture and ethnicity on learning style.

Curry's (1987) review is concerned with the psychometric properties of measures of learning style. Her article examines 21 measures of style, focusing on issues of reliability and validity, issues which continue to be raised as a matter of concern in the area (Rayner & Riding, 1997).

Whilst each of these reviews offers a slightly different perspective on the topic, the impetus for each of them is the wish to rationalise an area littered with a confusing array of terms, definitions, models, and measures.

Theories, Models, and Measures

The following discussion of learning style models and instruments is—as is frequently the case—by no means exhaustive. It is, however, fairly comprehensive and includes descriptions of most of the models at least referred to in recent and significant review papers (De Bello, 1990; Riding & Cheema, 1991; Rayner & Riding, 1997). The selection process certainly did not centre on identifying models which differed from each other in such a way as to provide alternative perspectives. Rather, the aim is to make a point of reported overlaps between different models in order to make explicit the need for rationalisation in research and practice and encourage readers to identify further similarities. Whilst it would, conceivably, be possible to compile an exhaustive list of instruments, this would probably include many derivatives and adaptations along with a number of instruments without an empirical base and an absence of reliability and validity data.

Witkin's Field-Dependence/Field-Independence (Wholist–Analytic Style Family/ Cognitive-Centred Approach / Cognitive Personality Style)

Model. Field-dependence/field-independence is essentially an individual's ability to disembed in perceptual tasks—likened to spatial intelligence (Widiger, Knudson, & Rorer, 1980)—and is associated with the ability to disembed in non-perceptual problem solving tasks (Riding and Cheema, 1991). Evidence that field-dependence was also relevant to intellectual ability as well as a range of other psychological competencies, such as sense of self, has led to the construct being given the broader label of "differentiation". As a style it associated with a general preference for learning in isolation (field-independence) as opposed to integration (field-dependence) (Witkin & Goodenough, 1981). Field-independent learners are characterised as operating with an internal frame of reference, intrinsically motivated with self-directed goals, structuring their own learning, and defining their own study strategies. Field-dependent learners on the other hand are characterised as relying more on an external frame of reference, are extrinsically motivated, respond better to clearly defined performance goals, have a need for structuring and guidance from the instructor, and a desire to interact with other

learners. These characteristics will clearly have implications for the preferred learning situation and consequently learning outcomes.

Measurement. Tests such as the Embedded Figures Test (EFT), involving the disembedding of a shape from its surrounding field, have been used to measure the construct.

Comments. Although it has stimulated a great deal of research in the field of education in particular, Witkin's theory is criticised on the following grounds: to generalise performance on perceptual tasks to personality and social behaviour is an over-extension of the theory (Griffiths & Sheen, 1992); and that field-independence—because of its high correlations with measures of intelligence (Arthur & Day, 1991)—is a measure of ability as opposed to style and therefore is of little value in the field of cognitive style.

Kagan's Impulsivity-Reflexivity (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model and measurement. Impulsivity-reflexivity is measured using the Matching Familiar Figures Test (MFFT) which requires familiar line drawing of objects to be matched against several possibilities. Individuals who make quick responses after briefly scanning the alternatives are labelled "cognitive impulsives" while those who scrutinise each alternative before making a final decision are labelled "cognitive reflectives".

Comments. Of note here is the association reported between field-dependence/field-independence and impulsivity-reflexivity with a number of studies reporting significant correlations between MFFT and EFT scores (for example, Massari & Massari, 1973). Reflectives are reported as more field-independent and impulsives as more field-dependent (Messer, 1976), indicating a significant overlap in the two constructs.

Convergent-Divergent Styles (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. Convergent style is characterised by the generation of the one accepted correct answer from the available information and divergent style as a propensity to produce a number of potentially acceptable solutions to the problem.

Measurement. Assessment of convergent thinking is the more straightforward of the two, using standard intelligence tests, multiple-choice items, as well as being inferred from performance on the EFT and MFFT. Because the number of

potentially correct answers is used as an index of divergent thinking, tests such as Uses of Objects Test and the Consequences Test are usual methods of assessment.

Comments. There are a number of suggested implications here: that certain subject areas may encourage, and therefore reward, convergent over divergent thinking (that is, science-related disciplines); that there needs to be a like-for-like match between teacher and student in terms of preferred style (Hudson, 1966); that, because of the inherent structure and routine in most formal educational settings, divergent thinking proves unpopular with teachers and is discouraged (Getzels & Jackson, 1962). There has been an association drawn between divergent thinking and field-independence (which is considered to be more creative), given that individuals scoring high on divergent thinking also score high on field independence (Bloomberg, 1971).

Holzman and Klein's Leveller-Sharpener Styles (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. Using the degree of complexity with which the individual perceives the task, Holzman and Klein (1954) introduced the style dimension leveller–sharpener. The leveller has a tendency to oversimplify their perceptions of the task, assimilating detail and reducing complexity. In contrast, the sharpener fails to assimilate effectively but instead introduces complexity, treating each piece of detail or event as novel. Assimilation is therefore the dimension defining this particular cognitive style, with levellers and sharpeners being positioned at the extremes of the continuum.

Measurement. The "failure to assimilate" characteristic is demonstrated by the Schematising Test which requires the individual to judge the size of a series of squares of light which get progressively bigger. The tendency is to underestimate the size of previous squares judged against the current larger squares. Whilst levellers show a particular sensitivity to this effect, sharpeners make more accurate estimations as a consequence of failing to assimilate current and past events (squares of light).

Comments. Whilst there is relatively little work utilising the leveller–sharpener cognitive style (Riding & Cheema, 1991), Riding and Dyer (1983) were able to identify similarities between this style and field-dependence/independence.

Pask's Holist–Serialist Style (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. Interestingly, Pask (Pask, 1972; Pask & Scott, 1972) makes the point that

whilst both groups operate through a different process for learning—in the end—both groups achieve a similar level of understanding. Serialists operate a step-by-step approach to learning, choosing to deal only with small amounts of information or material at any one time before going on to link these steps and achieve understanding. Holists on the other hand will utilise significant amounts of information from the start, looking to achieve understanding by identifying and focusing on major patterns or trends in the data. The serialists perceive the learning task in terms of a series of independent discrete topics and issues and focus on developing links between them, but for holists the focus is on the task as a whole. Pask observed the relative characteristics of serialists and holists as: serialists—step-by-step, logical linear progression, narrow focus, cautious and critical leading to a tendency to fail to see the task from a global perspective; wholists—broad perspective and global strategies resulting in a tendency to make hasty decisions based on insufficient information or analysis.

Measurement. Pask and Scott (1972) devised a series of problem-solving tasks which allowed individuals to adopt either a step-by-step or global approach to solving the task. Individuals adopting a step-by-step strategy to test simple hypotheses were labelled as serialists while holists were those individuals who attempted to reach a quicker solution by testing more complex hypotheses.

Comments. Riding and Cheema (1991) point out that despite being widely accepted, the dimension is based on only a relatively small sample and has not benefited from any empirical work examining its association with other learning styles. Notwithstanding these comments, Pask (1976) did report that holists scored higher on the Analogies Test and Divergence Test than serialists, suggesting possible similarities with the convergent-divergent style dimension.

Pavio's Verbaliser–Visualiser Cognitive Style (Verbaliser–Imager Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model and measurement. The assertion that individuals have an habitual propensity to process information either verbally or imaginally emanates from dual coding theory (Pavio, 1971) and may have important implications for learning. The verbaliser–visualiser cognitive dimension is assessed through tests examining individuals' ability to generate information not present but dependent upon the presence of a spontaneous image (Riding & Taylor, 1976). Individuals capable of responding quickly are considered visualisers and those with slower response rates verbalisers. Evidence exists to support the notion that, whilst the ability to switch between modes exists, some individuals rely heavily on one or other mode (Riding & Cheema, 1991). The fact that individuals have preferences for either visual or verbal thought has implication for learning. Alesandrini (1981) reported that the tendency for visualisation was inversely related to science and verbal analytical

ability, while the generally reported finding is that verbalisers learn best from text-based material and visualisers from pictorially presented material (Riding & Buckle, 1990). This suggests that a mismatch between learner and mode of presentation will adversely affect performance.

Gregorc's Style Delineator (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. Gregorc (1982) describes four distinctive and observable behaviours: abstract, concrete, random, and sequential tendencies. A combination of these tendencies is indicative of individual style. These tendencies are, Gregorc believes, reflective of in-born predispositions but individuals need to be capable of functioning outside their natural style. Four learning styles are identified: concrete sequential, featuring direct, step-by-step, orderly, sensory-based learning; concrete random, featuring trial and error, intuitive and independent approaches to learning; abstract sequential, featuring analytic, logical approaches and a preference for verbal instruction; and abstract random, featuring a preference for holistic, visual, experiential, and unstructured learning.

Measurement. The Style Delineator is a 40-item self-report inventory involving the rank ordering of sets of words. The format is similar to that of Kolb's (1976) Learning Styles Inventory and it has been suggested that observation and interviews should be used alongside the instrument to assist in the identification of learning style and preferences (De Bello, 1990). The measure identifies an individual's learning style according to Gregorc's model.

Comments. Rayner and Riding (1997) argue that the wholist–analytic dimension of cognitive style is present within Gregorc's model.

Kaufmann's Assimilator–Explorer Style (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. The assimilator–explorer cognitive style (Kaufmann, 1979) defines style in terms of an individual's propensity to solve problems through either novel or familiar strategies. The style was developed around problem-solving behaviour and has a close association with the use of creativity.

Measurement. A-E style is measured using a 32-item self-report questionnaire developed by Kauffmann and Martinsen (1991) in which individuals are scored according to their level of apparent desire for novelty (denoting explorers) or familiarity (denoting assimilators) in cognitive function.

Kirton's Adaption–Innovation Style (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. Grounded in an assumption that cognitive style is related to creativity, problem solving and decision-making strategies as well as aspects of personality, Kirton (1994) argued that style develops early in life and remains stable over both time and situation. Kirton introduced an adaption–innovation dimension along which cognitive style could be measured with adaptors characterised by the desire to do things better and innovators by the desire to do things differently.

Measurement. A-I is assessed using the Kirton Adaptor–Innovator Inventory (KAI), a 32-item self-report instrument developed for use with an adult population with both workplace and life experience. Seen as a measure of problem-solving style and creativity, the KAI is in frequent use in the field of management and training.

Allinson and Hayes' Intuition–Analysis Style (Wholist–Analytic Style Family / Cognitive-Centred Approach / Cognitive Personality Style)

Model. The Cognitive Style Index was developed by Allinson and Hayes (1996) in an effort to operationalise cognitive style for use in the area of management. It focuses on the dimension of intuition versus analysis which, Allinson and Hayes argue, represents a superordinate dimension of cognitive style. Hemispheric asymmetry underlies the dimension, with right brain orientation characterised by intuition with a tendency for rapid decision making based on feeling and the adoption of a global perspective. Left brain orientation is characterised by analysis where decisions are a result of logical reasoning focusing on detail.

Measurement. The CSI is a 38-item self-report questionnaire which provides a score suggestive of either an intuitive or analytic nature.

Kolb's Experiential Learning Model (ELM) and Learning Styles Inventory (LSI) (Learning-Centred Processed-Based Approach / Information Processing Style)

Model. Kolb (1976, 1984) proposes a four-stage hypothetical learning cycle. Individuals will show a preference for or will cope with some stages better than others and learning is seen as a continuous, interactive process. The four stages of the ELM are described as: concrete experience (CE; experiencing) which favours experiential learning; abstract conceptualisation (AC; thinking) where there is a preference for conceptual and analytical thinking in order to achieve understanding; active experimentation (AE; doing) involving active trial-and-error learning; and reflective observation (RO; reflecting) where extensive consideration is given to the task and potential solutions before there is any attempt at action. The four learning orientations form two orthogonal bipolar dimensions of learning.

The first dimension is prehension—the grasping of information from experience—and is constituted by the bipolar orientations CE–AC. The second dimension described is transformation—the processing of grasped information—and is constituted by the remaining orientations AE–RO. Relative positioning along these dimensions defines the learning styles described by Kolb as convergence, divergence, assimilation and accommodation. The individual who adopts a convergent approach uses abstract conceptualisation to drive active experimentation. Action is based on abstract understanding of the task and projected strategies for successful completion of the task. Divergers combine reflective observation with concrete experience to devise an often creative solution. Divergers are often described as creative learners because of their propensity to consider multiple potential strategies for learning and problem solving. Assimilators, concerned primarily with the explanation of their observations, favour abstract conceptualisation and reflective observation. As such, assimilators seek mainly to refine abstract theories rather than develop workable strategies and solutions. Lastly, Kolb defines the accommodator. Using active experimentation and concrete experience, these individuals have a clear preference for hands-on learning. The accommodator has been described as having a tendency for prompt action and a noted ability for adapting to diverse situations (Lynch, Woelfl, Steele, & Hanssen, 1998).

Measurement. Originally developed as a 9-item self-report scale (Kolb, 1976), the revised LSI (Kolb, 1985) is a 12-item self-report questionnaire. Respondents are required on each of the items to rank four sentence endings corresponding to each of the four learning styles. LSI scores reflect an individual's relative emphasis on the four learning orientations and enable categorisation according to the corresponding learning style. Two combination scores measure an individual's preference for abstractness over concreteness (AC–CE) and action over reflection (AE–RO).

Comments. Assertions that the styles outlined by Kolb will be associated with student performance have been borne out in a number of studies where, for example, convergers perform better on conventional examinations involving concrete answers (Lynch et al., 1998). Despite such support, studies examining the psychometric properties of the LSI have raised concerns regarding its reliability and validity (Freedman & Stumpf, 1981; Geiger, Boyle, & Pinto, 1992; Geller, 1979; Newstead, 1992; Sims, Veres, Watson, & Buckner, 1986).

Kolb's emphasis on experiential learning and the developmental nature of learning suggests a potential for change in style (Rayner & Riding, 1997). Studies which have examined stability and change using the LSI present a mixed picture. Low test-retest reliability statistics and changes in style classification reported by Sims et al. (1986) are countered by reports of exceptionally high test-retest reliability of 0.99 found by Veres, Sims, and Locklear (1991). Although also reporting high test-retest reliability

statistics, Loo (1997) is cautious about them, believing that inappropriate statistical techniques may be masking individual changes in style in favour of group effects.

The ELM forms the basis of the work of Honey and Mumford (1986) in the field of learning style and management and the development of their Learning Styles Questionnaire.

Honey and Mumford's Learning Styles Questionnaire (Learning-Centred Processed-Based Approach / Information Processing Style)

Model. Honey and Mumford's (1992) description and measurement of learning style is grounded in Kolb's experiential learning model, with styles closely corresponding to those defined by Kolb. The Learning Styles Questionnaire (LSQ) was developed for use with management trainees and has been proposed as an alternative to Kolb's LSI. The four learning styles measured by the LSQ are: activist (Kolb's active experimentation); reflector (Kolb's reflective observation); theorist (Kolb's abstract conceptualisation; and pragmatist (Kolb's concrete experience).

Measurement. The LSQ is an 80-item self-report inventory based on Kolb's ELM but developed specifically for use in industry and management. Individuals' tendency towards a preferred learning style is indicated by their ratings of behavioural and preference orientations.

Comments. Although developed for use with management trainees, the LSQ has been used in a range of settings including education. However, concerns regarding the psychometric qualities of the LSQ have been raised. Duff and Duffy (2002) report a failure to support the existence of either the bipolar dimensions or learning styles proposed by Honey and Mumford and found the LSQ to have only modest levels of internal consistency (ranging from 0.52 to 0.73 for the four style subscales). Given that their sample was 388 undergraduate students, Duff and Duffy conclude the LSQ is not an acceptable alternative to the LSI and that its use in the field of higher education is premature.

Vermunt's Learning Styles Inventory (LSI) (Learning-Centred Processed-Based Approach / Information Processing Style)

Model. Vermunt (1992) describers the concept of learning style in terms of: processing strategies, including an awareness of the aims and objectives of the learning exercise used to determine what is learnt; regulation strategies, which serve to monitor learning; mental models of learning, encompassing the learner's perceptions of the learning process; and learning orientations, described as personal aims, intentions and expectations based on past experience of learning. Based on these strategies and orientations, Vermunt derives four learning styles: undirected,

where there is difficulty in assimilating learning material, coping with the volume of material and prioritising the importance of components of the material; reproduction, where little or no effort is made to understand but instead information is reproduced to complete the task or achieve the minimum required standard; application directed, which is characterised by the application of learning material to concrete situations in order to gain understanding; and lastly, meaning directed learning, which involves attempts to gain a deeper understanding of learning material and to draw on existing and related knowledge to achieve critical understanding. Vermunt's Learning Styles Inventory (LSI) was developed as a diagnostic tool for use in a higher education context.

Measurement. The degree to which each of the four styles is favoured is assessed using Vermunt's LSI (Vermunt, 1994). The LSI comprises 20 subscales and 120 items relating to study strategies, motives and mental models. Individuals respond to statements along a five-point scale according to the degree to which the statement is descriptive of their behaviour or the extent to which they agree with the statement.

Comments. Vermunt's (1992) own reports of acceptable reliability and validity of the LSI received some support form Busato, Prins, Elshout, and Hamaker (1998) who confirmed the existence of four factors corresponding to learning styles described by Vermunt.

   The influence of Kolb, Honey and Mumford, and Entwistle and Tait (see below) all seem present in Vermunt's approach to the assessment of learning styles.

Entwistle et al.'s Approaches to Study Inventory (Learning-Centred Process-Based Approach / Information Processing Style)

Model. Based on earlier work by Marton and Saljo (1976) Entwistle, Hanley, and Hounsel (1979) developed an instrument for assessing learning style which focuses on the level of engagement or depth of processing applied during learning. The proposed model centres around four modes of orientation of the learner: meaning orientation; reproduction orientation; achieving orientation; and holistic orientation. Tendencies towards particular combinations of orientations identify individuals as conforming to one of the following learning styles: deep (intention to understand, relating ideas, use of evidence, and active learning); surface (intention to reproduce, unrelated memorising, passive learning, and fear of failure); strategic (study organisation, time management, alertness to assessment demands, and intention to excel); and apathetic (lack of direction and lack of interest).

Measurement. The original 64-item ASI has undergone a number of revisions, its most radical in 1994 when it was abbreviated to 38 items, and then to 44 items in

1995 (Entwistle & Tait, 1995). The revised ASI (RASI) is a 44-item self-report inventory of learning activities using a Likert scale response format. The RASI now identifies six approaches to learning: deep approach; surface approach; strategic approach; lack of direction; academic self-confidence; and metacognitive awareness of studying.

Comments. The ASI inventory has been used extensively in educational research and a recent study examining the psychometric properties of the RASI and its utility in an educational setting recommends its continued use for educational management and research (Duff, 2000).

Biggs' Study Processes Questionnaire (SPQ) (Learning-Centred Process-Based Approach / Information Processing Style)

Model and measurement. Entwistle's model was further developed by Biggs (1985) to incorporate an extended motivational dimension defined as intrinsic, extrinsic and achievement orientation. Bigg's study processes measure includes both a strategy dimension—deep/surface—and a motivational dimension—deep/surface.

Measurement. Originally a 42-item self-report questionnaire, the revised two-factor SPQ (Biggs, Kember, & Leung, 2001) has 20 items and provides scores in relation to strategy (deep/surface) and motive (deep/surface). An overall composite score is indicative of a consistently deep or surface approach to learning. Achieving approach is no longer separated out as in earlier versions.

Schmeck's Inventory of Learning Processes (ILP) (Learning-Centred Process-Based Approach / Information Processing Style)

Model. Schmeck et al.'s (1977) learning processes style construct is developed around the belief that it is the quality of thinking during learning which affects the learning outcome. Like the models proposed by Entwistle and Biggs, the learning process model follows the work of Marton and Saljo (1976), focusing on learning orientations with an emphasis on information processing (Duff, 2000). The four subscales of the ILP are: synthesis–analysis; elaborative processing; fact retention; and study methods (Rayner & Riding, 1997).

Measurement. The ILP was originally a 62-item self-report inventory with the four subscales identified above. A revised version (ILP-R) has 160 items and seven subscales (Schmeck, Geisler-Brenstein, & Cercey, 1991). However, each version of the ILP has come under heavy criticism and Richardson (2000) concludes that the ILP cannot be recommended for use in investigating student learning.

Hunt et al.'s Conceptual Level Model (Learning-Centred Process-Based Approach / Information Processing Style)

Model. Hunt, Butler, Noy, and Rosser (1978) described learning style in terms of an individual's need for structure and the conditions under which that individual will learn most effectively. Students requiring a highly structured learning environment, who are impulsive and concrete, are described as having a low conceptual level (CL). High CL students are independent, inquiring, self-assertive, and have little or no need for structure. The aim of the model therefore is to match students' learning style with the most appropriate methods of teaching.

Measurement. The Paragraph Completion Test requires individuals to complete and elaborate on six incomplete sentences. Because responses are scored according to their degree of complexity, scoring and interpretation of the test requires specialist training (De Bello, 1990).

Comments. Suedfeld and Coren (1992) reported an association between conceptual level and divergent thinking and support the existence of the construct as a cognitive style rather than a mental ability. Some evidence for the validity of the CL model was presented by McLachlan and Hunt (1973) who found that low CL students showed significant benefit in their learning from a high as opposed to a low structure teaching method. It was also reported that teaching method did not impact significantly on learning in high CL students. In line with such findings, Hunt believes that although teaching needs to be geared towards students' learning style to facilitate learning, there may be a developmental component to style which would allow for teaching methods to become gradually less structured to encourage more independent learning.

Dunn et al.'s Learning Styles Inventory (LSI) (Learning-Centred Preference-Based Approach / Instructional Preference / Social Interaction)

Model and measurement. Dunn, Dunn and Prices' (1989) LSI is a 100-item self-report questionnaire asking individuals to respond to items relating to the key factors of the construct: environmental (light, sound, temperature, and design); emotional (structure, persistence, motivation, and responsibility); sociological (pairs, peers, adults, self, and group); physical (perceptual strengths: auditory, visual, tactile, kinaesthetic, mobility, intake, and time of day); and psychological (global-analytic, impulsive-reflective, and cerebral dominance). Versions of the scale have been developed for use with primary and secondary school children and with adults (the Productivity Environmental Preferences Survey). The factors are reported independently to provide profiles which can be used to guide the construction of the learning situation, material and teaching approach.

Comments. Curry's (1987) review of different learning/cognitive style models reports the LSI as having one of the highest reliability and validity ratings. The LSI has also been identified as being practitioner oriented and the most widely used assessment for learning style in elementary and secondary schools (Keefe, 1982).

Riechmann and Grasha's (1974) Style of Learning Interaction Model (Learning-Centred Preference-Based Approach / Instructional Preference / Social Interaction)

Model. Described as a social interaction scale (Jonassen & Grabowski, 1993), the style of learning interaction model focuses on learner preferences but introduces social and affective dimensions to the measurement of style. The three dimensions described by the model are: avoidant-participant; competitive–collaborative and dependent–independent. The model incorporates the belief that style is, to some degree, fluid and will alter according to the learning situation.

Measurement. The Student Learning Styles Scale (SLSS) is a 90-item scale presented in two versions, one to assess class style and one to assess individual style.

Comments. Rayner and Riding (1997) note the similarity between the style of learning interaction model and the model proposed by Dunn et al. (1989) because of the focus on learning preferences.

Ramirez and Castenada's (1974) Child Rating Form (Learning-Centred Cognitive Skills-Based Approach / Cognitive Personality Style / Instructional Preference / Social Interaction)

Model and measurement. The model incorporates the cognitive style dimension field-dependence/field-independence (Witkin, 1962) and focuses particularly on cultural differences and minority groups. Field-independence is viewed as positive because its associated traits (detail orientated, independent and sequential) are those which Ramirez believes are rewarded by schools. The Child Rating Form is a direct observation tool measuring behaviour frequencies which is completed by teachers or can be completed as a self-report questionnaire by the student.

The Edmunds Learning Style Identification Exercise (ELSIE) (Reinert, 1976) (Learning-Centred Cognitive Skills-Based Approach / Cognitive Personality Style)

Model and measurement. Described as a form of assessment which aims to "provide the teacher with information which will be used to work to the student's strengths or preferred mode of responding to learning stimuli" (Rayner & Riding, 1997, p. 19), the ELSIE aims to identify the individual's natural perceptual modality in the context of a learning situation. The 50 one-word items of the instrument assess

response in terms of imagery, verbalisation, sound, and affect. Similarities between ELSIE and several other models including those of Dunn et al. (1989), Hill (1976) and Keefe and Monks (1986; the NASSP-LSP) have been noted.

Hill's Cognitive Style Interest Inventory (Learning-Centred Cognitive Skills-Based Approach / Cognitive Personality Style)

Model. Defining learning style in terms of the unique way in which an individual searches for meaning, Hill (1976) used a process of cognitive style mapping, attempting to establish perceptual modality (auditory/visual), modalities of inference (such as critical thinking and hypothesis testing), and cultural determinants in order to integrate learning style with curriculum design. Hill labelled the resulting construct "educational cognitive style".

Measurement. The Cognitive Style Interest Inventory is a 216-item self-report questionnaire designed to assess educational cognitive style using the following categories: symbols and their meaning (perceptual modality); modalities of inference; and cultural determinants. There is also an interview component to the measure.

Comments. The instrument itself suffers from a lack of empirical support (Jonassen & Grabowski, 1993), poor reliability and validity (Curry, 1987) and has been criticised for the elaborate and time-consuming nature of the instrument (De Bello, 1990). De Bello (1990) draws comparisons between Hill's model and both Ramirez and Castenada's (1974) model, because of the identification of cultural differences, and Dunn et al.'s (1989) model because of the influence of peer and family orientation.

Letteri's Learner Types (Learning-Centred Cognitive Skills-Based Approach / Cognitive Personality Style)

Model. Viewing learning essentially as information processing involving the effective storage and retrieval of information, Letteri (1980) was concerned with the diagnosis of ineffective cognitive processing and advocated interventions teaching effective cognitive skills. The model identified three types of learner: Type 1 is reflective and analytic; Type 3 is impulsive and global with a lack of direction; and Type 2 falls midway between Types 1 and 3 in approach to learning. Letteri provided evidence linking Type 1 learners with above average and type 3 learners with below average academic success.

Measurement. Letteri's instrument represents a number of existing cognitive dimensions, including field-independence/field-dependence, impulsivity–reflexivity,

scanning/focussing and levelling/sharpening, which are assessed through a series of bipolar continuums. In general, bipolar extremes correspond to either wholist (global) or analytic characteristics.

Keefe and Monks' (1986) Learning Style Profile (Learning-Centred Cognitive Skills-Based Approach / Cognitive Personality Style, Instructional Preference and Social Interaction)

Model. Keefe and Monks' (1986) Learning Style Profile (LSP) was the result of extensive re-examination of existing learning style models with the aim of developing a single instrument capable of assessing learning style across the range of already established characteristics. The LSP assesses style in three areas: cognitive skills, including information processing and memory; perceptual response to visual and auditory stimuli; and study and instructional preferences, including motivation and environmental preferences. The model is intended for use in the development of educational programmes and focuses on the development of effective cognitive skills for learning.

Measurement. The LSP is a 126-item assessment tool for secondary students which includes self-report items and cognitive tasks (derived from the EFT). Responses are computer scored and provide students with an individual learning style profile.

Comments. Not surprisingly, given its origins, the LSP has been found to correlate significantly with other instruments, most notably Dunn et al.'s (1989) LSI and Reinhart's (1976) ELSIE (Curry, 1987; Keefe & Monks, 1986). Commenting on these reported correlations, De Bello (1990) notes Curry's (1987) concerns regarding the reliability and validity of ELSIE.

Learning Styles in Action—Some Examples

Interest in defining, characterising and studying the associated effects of learning style results—mainly—from its distinction from ability and its association with performance. Whereas the relationship between ability and performance is relatively straightforward, such that performance improves with increased ability, the effects of style on performance are contingent on the nature of the task. For example, imagers are likely to perform better on pictorially-based tasks than on verbal-based tasks (Riding, 1997). In support of the independence of learning style and intelligence, Riding and Pearson (1994) found that there were no significant correlations between intelligence—as measured by the British Abilities Scale—and the wholist–analytic and verbal–imager dimensions of learning style. A less clear distinction between learning style and personality is presented (Riding & Wigley, 1997), although only a tentative link is reported. The identification of an individual characteristic, separate form

ability, which impacts on learning performance has led to the application of learning style theory and measurement in a number of diverse areas.

Academic Achievement

Cassidy and Eachus (2000) used the Approaches and Study Skills Inventory for Students (Tait & Entwistle, 1996) to measure learning style in undergraduate students. They found that academic achievement was positively correlated with a strategic approach, negatively correlated with an apathetic approach, and unrelated to a deep approach to learning. Learning style was also found to correlate significantly with other academic performance-related factors such as academic self-efficacy and academic locus of control.

Clinical Training in Medical Schools

McManus, Richards, Winder, and Sproston (1998) found, in a large-scale prospective study of two cohorts of medical students at a London medical school, that the students' learning styles, but not their final examination results, were related to the amount of knowledge gained from clinical experience. Using an abbreviated 18-item version of the Study Process Questionnaire (Biggs, 1987) they reported positive correlations between strategic and deep learning styles and amount of knowledge gained from clinical experience.

Career Development

In reviewing weaknesses in current practices within industry towards the retention and development of individuals labelled as "high flyers", Bates (1994) lists learning style as one key factor. Bates cites Honey and Mumford's (1986) model of learning style as an appropriate model for individual learning and one capable of encompassing a framework for high flyer development. In the move to cultivate the "top managers" of the future, Bates calls for individual learning styles to be taken into account through the provision of a variety of learning situations which should create the opportunity for the development of a full range of styles.

Police Training

In a review of existing methods of police training in the U.S., Birzer (2003) criticises traditional behavioural approaches in favour of instructional methods which recognise individual differences in learning. Citing recent studies identifying individual approaches to learning, Birzer illustrates the paradoxical way in which much police training is currently delivered with little regard for individual differences in learning, and calls for a more student-centred approach to training in the future.

These examples illustrate the range of potential applications of learning style and underline the need to promote clarification and rationalisation in the field.

Working with Learning Style

The researcher or practitioner entering the area of learning style may well do so with some sense of trepidation given the volume, diversity and apparent dissociation of writing, theory and empiricism in the field. De Bello (1990) notes that there exist almost as many definitions as there do theorists in the area. For the academic concerned with pure theory this may offer an exciting challenge. For those working within an educational setting wishing to utilise learning style to promote more effective learning, whether through individual or group profiling, design of instructional methods, or identifying learner preferences, operationalising learning style is a necessary but highly problematic endeavour. Curry (1991) highlights the failure to identify and agree upon style characteristics most relevant to learners and instructional settings as a major concern in the field. She also identifies two further concerns relating to weaknesses in reliability and validity and confusion surrounding definitions and terminology.

If further work is introduced which is not based on a sound grasp of key concepts, an awareness of continuing problems, a desire to address central issues and report findings in an integrated manner, these weaknesses are likely to be compounded. There is a need then to embark "from within" on a programme of rationalisation and to provide guidance for ongoing research and practitioner work. It may well be, as De Bello (1995) comments, that many or all of the proposed models of learning style are valid and, as is the case in most areas of psychology, will simply offer approaches with different emphases for investigation. What is necessary is further empirical work to provide evidence to assess the validity of many of the proposed models. Perhaps of more use, particularly from the practitioners' point of view, is work concerned with integration and rationalisation. The latter reflects the tone of much of the influential writing in the area which calls for identification of, and focus on, basic individual differences which form the foundations of learning style and the convergence upon fundamental dimensions of style. Existing attempts at rationalisation (Curry, 1987; Rayner & Riding, 1997; Riding & Cheema, 1991) already present a clustering effect for LS models (see Table 1) which is helpful for the application of LS and provides a direction for further work on rationalisation in the field.

On choosing the right model or instrument for investigation or application, De Bello suggests that there should be assessment of both the available evidence for the reliability and validity of the model and its associated measure and the extent to which the model has been utilised in research and practitioner-based work. As Riding and Cheema (1991) note, many models have received very little attention since being initially proposed by their author. Prior to establishing psychometric properties and extent of utilisation, it is suggested here that there is a need to become familiar with the field of learning style, to become conversant with its idiosyncrasies, weaknesses, terms and definitions and choices available, and to ensure that the proposed work has clear and specific objectives. Once the objectives of the venture, be it research-based or application/practitioner-based, have been identified, these can then be matched in a specific manner with the suggested utility of an appropriate model of LS. For

example, is the work concerned with developing instructional methods for learners or is there a desire to measure approaches to learning (such as deep/surface) and establish how these relate to learner achievement? There needs to be a deliberate and documented choice of model which reflects a broad awareness of the field and which will allow for results and outcomes to be dealt with within a clear conceptual framework. Following such guidance should contribute to the development of a unifying conceptual and empirical framework of learning style.

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