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A Critical Review of Learning Styles in Higher Education

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Abstract
The vast literature on styles related to learning is characterised by a myriad of models which can be broadly classified as based on either personality, cognition or instructional preference. The present review identifies 26 style models in addition to the 30 classified by previous researchers. The literature also reveals considerable confusion regarding the conceptual distinctions between styles, abilities and types. A detailed analysis is presented of three style models which have been researched extensively. It is concluded that style models ultimately reduce to type classifications of individual differences which are treated as falling into discrete (typically binary) categories when in reality they vary across continuous dimensions. A new model is presented which accommodates styles within the context of abilities, preferences and activities which together determine learning outcomes. This paper argues that designing higher education course delivery in terms of stereotyped styles will not serve all learners and may well disrupt the learning of those whose abilities and preferences do not fall at the extremes of the various dimensions. As well as accommodating individual differences, it is argued that academics need to develop the competencies of students beyond their stylised preferences.

1. Introduction
The most widely accepted basis for analysing individual differences in how people learn is the construct of ‘style’ encompassing both cognitive styles and learning styles (Riding, 1997). Although not without its critics (e.g., Stellwagen, 2001; Reynolds, 1997; Tiedemann, 1989), the style approach has been applied extensively in primary schooling (Searson & Dunn, 2001) and secondary schooling (Haar et al., 2002; Snyder, 2000) as well as in higher education (McClelland, 2001; Buxeda & Moore, 2000; Busato et al., 1998).
However, there is a lack of consensus in the literature about which of the many style models are most relevant for educational practice. For example, in relation to multimedia delivery which is becoming increasingly important in higher education, Dillon and Gabbard (1998) review research using three of the models of learning style: field dependence versus independence, surface versus deep processing of information, and activity versus passivity. Smith and Woody (2000), by contrast, use the visual/verbal style model and conclude that multimedia is most effective for visual rather than verbal learners. Another commonly researched model in educational multimedia is the Kolb (1984) Learning Style Inventory (see Karakaş, 2001; Kettanurak et al., 2001; Kraus et al., 2001). The more recent model advanced by Riding and Cheema (1991) attempts to integrate the many different style approaches. Whether this integrated model provides the focus needed by both theorists and educational practitioners will be addressed in the present review. This paper aims to explore the extensive and diverse literature on learning styles in an attempt to derive practical implications for higher education.

2. The Style Construct

2.1. Origins of the Style Concept

As Sternberg and Grigorenko observe, “styles have a fairly long but varied history in the context of theory and research in psychology. Like wide neckties, research on styles tends to come and go” (1997, p.709). Some writers suggest that the notion of style has its roots in the 1920s with Jung’s theory of psychological types which forms the basis of the currently popular Myers-Briggs Type Indicator (MBTI) (Sternberg & Grigorenko, 1997). Others trace the style construct as far back as the study of individual differences in the 1880s, specifically, the finding that some people prefer visual and some verbal approaches to thinking (Riding, 1997). However, it could be argued that the conceptual foundations of the style approach date back to the ancient Greek philosophers who identified four temperaments (sanguine, melancholic, phlegmatic and choleric) a framework that has evolved over two millennia into modern conceptions of style (Heineman, 1995).

2.2. Conceptions of Style

Two decades ago, Curry attempted to address “the bewildering confusion of definitions surrounding learning style conceptualizations” by proposing a “learning style onion” (Curry, 1983, p.1). This classification posits an outer layer comprising instructional
preference models of style, with a second layer comprising information-processing models and an inner layer comprising personality-based models. As well as being a classification of style models Curry’s “reconceptualization” can be seen as a model of human learning. At the inner core is the “underlying and relatively permanent personality dimension” (Curry, 1983, pp.11-12) which determines how an individual adapts to and assimilates information. At the next level, we have the “individual’s approach to assimilating information” (Curry, 1983, p.11) which is less permanent and able to be modified by learning strategies. At the top and least stable level, interacting directly with the external world, is the individual’s instructional preference or choice of learning environment. Curry’s approach is a useful contribution to styles because it highlights that there are three different conceptions of style focused on three different components of human learning: personality type, cognitive abilities, and instructional preference. Indeed, as will be shown in the current review, the whole edifice of styles is precariously founded on an over-simplification of and confusion among these distinct dimensions of individual differences.

A decade later, Curry presented an “integrative learning style taxonomy” (Curry, 1991, p.249) (see Figure 1) developed from her earlier ‘learning style onion’ (Curry, 1983). While the earlier classification system provided an implicit model of human learning (comprising personality, information processing and instructional preference), the revised approach seems to be more a causal model of learning style. Curry’s new model postulates ‘preference for various environmental conditions’ and ‘preference for various social conditions’ as the fundamental constructs (see Figure 1). An arrow (implying causality) leads from these constructs to ‘motivation maintenance’ which in turn leads to ‘level of task engagement’ then to ‘cognitive controls’ which determine ‘learning style’. A person’s learning style together with their ‘metacognitive skills’ and their ‘specific knowledge and skills’ (depicted in the model as moderating variables) determine the ‘learning outcome’ (see Figure 1). However, despite the use of arrows implying causality, it seems that Curry (1991) intends her model to depict the components rather than the determinants of learning style. She states that “Learning style itself can be conceived as a combination of one’s motivation, engagement and cognitive processing habits”, and later refers to these three as “the collection of factors that make up learning style” (Curry, 1991, p.252; italics added). At best, it must be concluded, Curry’s new model as depicted in Figure 1 is internally inconsistent.
Curry (1991) presents a table showing that some style measurement models address environmental conditions preference, some address social conditions preference, some address typical engagement level and some address cognitive information processing preference. In this revised approach, the taxonomy or classificatory system is provided not by the new model but by Curry’s proposition that different style measurements (and conceptualisations) apply to the different determinants of learning style.

Figure 1. Curry’s Theoretical Model of Learning Style Components and Effects

Source: Curry (1991, p.249)
Another conception of style is provided by Sternberg and Grigorenko (1997) who suggest that there have been three separate traditions in research on styles, namely, cognition-centred, personality-centred and activity-centred. According to Sternberg and Grigorenko (1997: 703), the style models in the cognition-centred tradition “most closely resemble abilities and, like abilities, have often been measured by tests of maximal performance”. By contrast, “the styles produced by the personality-centred approach seem closer to personality traits [which are] measured by typical-performance tests rather than maximal-performance tests” (Sternberg & Grigorenko, 1997, p.704). Finally, the activity-centred approach is based on “the notion of styles as mediators of various forms of activities that may arise from aspects of cognition and personality… [specifically] learning styles… [and] teaching styles” (Sternberg & Grigorenko, 1997, p.705). While this classification is much-quoted in the recent literature, it is hardly an advance on the original Curry framework. In fact, the Curry (1983) ‘onion’ model has the advantage of proposing a hierarchical structure for style approaches which is lacking in the broadly comparable Sternberg and Grigorenko (1997) framework.

Finally, Riding and Rayner (1998) identify two traditions in research on style and offer the following categorisation of style models:

1. Models in the cognition-centred tradition:
   - models featuring the wholist-analytic dimension,
   - models featuring the verbal-imagery dimension,
   - models which integrate both of these dimensions;

2. Models in the learning-centred tradition:
   - models based on the learning process,
   - models grounded in orientation to study,
   - models based on instructional preference,
   - models based on cognitive skills development.

This classification is explored further in the next section on cognitive and learning styles and in the section on style models (see Section 3.1).
2.3. Cognitive Style Versus Learning Style

Throughout the literature there is a lack of consistency in the use of the terms cognitive style and learning style. According to Reynolds (1997, p.130), “Whether the terms learning style and cognitive style mean the same thing depends on the user’s perspective”. Riding and Rayner (1998), however, argue that cognitive style and learning style are distinct as implied by their categorisation outlined in the previous section. They assert that: “when used more exactly or precisely, the term ‘learning style’ should be understood to refer to an individual set of differences that include not only a stated personal preference for instruction or an association with a particular form of learning activity but also individual differences found in intellectual or personal psychology” (Riding & Rayner, 1998, p.51). They also argue that models of learning style are based on the learning tradition and do not address individual differences in the learner but only in the learning process. They go even further to suggest that learning style models do not really relate to style at all but rather to ‘learning strategies’. Style and strategy need to be distinguished according to Riding and Rayner who state: “Style probably has a physiological basis and is fairly fixed for the individual. By contrast, strategies are ways that may be learned and developed to cope with situations and tasks, and particularly methods of utilising styles to make the best of situations for which the styles are not ideally suited” (1998, p.11).

A relatively late entry into the style lexicon is the term ‘thinking style’ introduced by Sternberg (1988, 1997), which refers to the way people use their abilities and manage their activities. Sternberg sees thinking styles as “but one manifestation of a broader program of research in which psychologists have been engaged for many decades, that on cognitive styles, or people’s characteristic and typically preferred modes of processing information” (Sternberg & Grigorenko, 1997, p.700; italics in original). As many as 13 thinking styles were distinguished by Sternberg although Zhang (2002, p.248) claims that “7 of these thinking styles can be categorized broadly into two types” yielding a net 8 styles. Research by Zhang (2001) indicates that the construct of thinking style is more than closely related to the construct of teacher approach (which distinguishes two approaches, conceptual change/student-focused versus transmission/teacher-focused). As Zhang concludes on the basis of an empirical study of 76 trainee teachers measuring both approach and style: “The differences between approaches and styles are in degree, but not in kind” (2001, p.558). However, I would argue that this means there is no substantive or
logical difference—when things differ in degree but not in kind they are not really different things but only different amounts of the same thing. In other words, Zhang’s (2001) conclusion calls into question the validity of both constructs, teacher approach and thinking style.

2.4. Style Versus Ability Versus Type

A central conceptual issue surrounding style is how it relates to ability and type. Messick (1984) conducted what is generally accepted as the definitive comparison of style and ability. He proposed a classification of properties which differentiates abilities from styles as summarised in Table 1. In fact, Messick’s (1984, p.65) model portrays styles and abilities as the two ends of a continuum ranging sequentially from what he termed “intellective abilities” to “cognitive controls” to “stylistic abilities” to “cognitive styles”. However, only the two endpoints, abilities and styles, are of central interest to both his and the current analysis.

Table 1. Messick’s Criteria for Distinguishing Cognitive Styles and Intellective Abilities

<table>
<thead>
<tr>
<th>Abilities</th>
<th>Styles</th>
</tr>
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<tbody>
<tr>
<td>1 Content/level of cognition</td>
<td>Manner/form of cognition</td>
</tr>
<tr>
<td>2 Competencies</td>
<td>Propensities</td>
</tr>
<tr>
<td>3 Maximal performance</td>
<td>Typical performance</td>
</tr>
<tr>
<td>4 Unipolar</td>
<td>Bipolar</td>
</tr>
<tr>
<td>5 Value directional</td>
<td>Value differentiated</td>
</tr>
<tr>
<td>6 Domain specific</td>
<td>Pervasive</td>
</tr>
<tr>
<td>7 Enabling</td>
<td>Organising &amp; controlling</td>
</tr>
</tbody>
</table>

Source: Messick (1984)

The first distinguishing property is that of content/level versus manner/form of cognition (see Table 1). Ability refers to “the questions of What? and How much? What kind of information is being processed by what operation in what form and how well?” whereas style refers to “the question of How?” (Messick, 1984, pp.62-63). The second and third properties (see Table 1) distinguish the two constructs in terms of measurement with abilities measured as “competencies in terms of maximal performance, with the emphasis on accuracy and correctness of response” whereas styles are measured as “propensities in
terms of either *typical* or *contrasted* performance, with the emphasis on either customary or predominant processing mode” (Messick, 1984, p63; italics in original).

The fourth distinguishing property appears quite straightforward: abilities are *unipolar* whereas styles are *bipolar* in that they “range from one extreme to a contrasting extreme, with each pole of the dimension having different implications for cognitive functioning” (Messick, 1984, p.63). However, in his next sentence Messick cites an example which seems to blur the picture: “The field-independent person, for example, is relatively more analytical than a field-dependent person, who in turn is relatively more socially sensitive” (Messick, 1984, p.63). Surely there are two distinct dimensions in this example rather than the required bipolar (and logically implied single) dimension. Being socially sensitive is not the opposite of being analytical but rather is a separate capacity, indeed it could be argued, a separate ability. Although Messick’s example is clearly inappropriate, the distinguishing property unipolar-versus-bipolar is nevertheless clear-cut (see Table 1).

The fifth distinction sees abilities as *value directional* (“having more of an ability is better than having less”) whereas styles are *value differentiated* (“each stylistic extreme has adaptive value but in different circumstances”; Messick, 1984, p.64). The sixth property distinguishes abilities which are “*specific to a particular domain of content or function*, such as verbal, numerical, and spatial ability or fluency and memory ability” from styles which “*cut across ability, as well as other cognitive, personality, and interpersonal domains*” (Messick, 1984, p.63; italics in original). The final distinction is that “abilities are *enabling* variables in the sense that abilities facilitate task performance in specific areas, whereas cognitive styles are *organizing and controlling* variables” (Messick, 1984, p.63; italics in original).

Although Messick’s (1984) much-cited analysis seems to provide a clear conceptual basis for distinguishing styles and abilities, he clouds the analytic magnifying glass when he states after outlining his model:

> It should again be emphasized that these differences have been stated in somewhat idealized or stereotypic terms and thus represent distinctions between pure forms, as it were, of the two constructs. These distinctions are not so sharply etched in actuality – there are varying degrees of difference
In this statement Messick appears to confuse the nature of conceptual and empirical analysis. His model purports to be and is widely used in the literature as a set of criteria (which he calls “properties”) which define and differentiate the constructs of style and ability. As he describes his model, “These distinctions are integrated into a unified framework that serves to define cognitive styles in contrast not only to abilities but to other types of stylistic variables” (Messick 1984, p.59; italics added). He seems to ignore that conceptual as distinct from empirical analysis is all about ‘pure forms’. It is certainly true ‘in actuality’, as Messick puts it, that there are many conceptions and measurements which are not ‘pure forms’ insofar as they claim to be about style but fail to meet one or more of his seven defining criteria (see Table 1) and should, therefore, be classified either as abilities or as one of his intermediate constructs, stylistic abilities or cognitive controls. In the present review, as in the literature, Messick’s (1984) criteria will be used as the benchmark to define the construct under analysis, namely, ‘style’.

The next issue to be addressed is whether there is a difference between style and type. The answer is that style classifications ultimately reduce to type classifications as will be shown later for the major style models. According to Vernon (1973): “the type (like the stereotype) was employed more as a subjective generalization about people than as an empirical clustering of attributes, and the same weakness is apparent in many of the modern styles” (cited in Messick, 1984, p.59). The notion of type is arguably most soundly based in relation to personality where it is most widely accepted. However, personality typing involves classifying people on the basis of differences which are continuous rather than discrete. The most extensively researched approach to personality type is the Myers-Briggs Type Indicator (MBTI) which also forms the basis of one of the many approaches to cognitive style (Briggs & Myers, 1977).

The MBTI classifies personality (and cognitive style) into 16 types on the basis of measures on four supposedly bipolar behavioural dimensions (viz., energising dimension: extraversion vs introversion; attending dimension: sensing vs intuition; deciding dimension: thinking vs feeling; living dimension: judgement vs perception) (Briggs & Myers, 1977). However, none of these dimensions is really bipolar for the supposed poles are different behaviours based on distinct abilities and preferences. Consider the most
bipolar-looking dimension, extraversion-introversion. If they were bipolar, these two behavioural characteristics would vary inversely, that is, as one increases the other would decrease. However, as with all four dimensions, the MBTI yields separate scores for extraversion and introversion which vary independently (confirming that they are not bipolar) and then it simply types people as ‘E’ or ‘I’ according to which score is higher. Thus, a person who is very high on extraversion and very low on introversion (the ‘classic extravert’) and a person who scores moderately on the two but is slightly higher on extraversion, are both classified as an ‘E’ (extravert) type. Clearly, the MBTI treats continuous variations as discrete differences – the 16 types are not only over-simplifications but they are artefactual and inaccurate depictions of individual differences. The MBTI provides a summary of complex individual differences which has proved useful in practical situations. However, it should not be forgotten that there are not 16 types of people in reality, only individuals who differ continuously in abilities and preferences on various dimensions but are put into 16 ‘boxes’ for the sake of simplifying real-world complexities.

Reynolds (1997) argues for the discontinuation of labelling in terms of learning styles observing that “preoccupations with psychological constructions such as ‘style’ result in distorted perceptions of social context” (1997, p.123). He cites a pertinent and somewhat ironic quote by Kolb (1984):

> Psychological categorizations of people such as those depicted by psychological ‘types’ can too easily become stereotypes that tend to trivialize human complexity and thus end up denying human individuality rather than characterizing it (cited in Reynolds, 1997, p.126).

3. The Measurement of Style

3.1. Models of Style

In a broad and influential review, Rayner and Riding (1997) identify a total of 30 styles including 18 different models of cognitive style which they classify into three categories: 14 classed as wholist-versus-analytic, 3 as verbal-versus-imagery and one as wholist-analytic plus verbal-imagery (see Table A1 in the Appendix). They further identify 12 models of learning style again with three categories: 5 process-based models, 2 preference-based models and 5 cognitive-skills-based models (see Table A2). The present
review has located 26 additional models in the literature, specifically, 7 more cognitive style models (6 of which can be classified as wholist-analytic and 1 as verbal-imagery; see Table A3) and an extra 19 learning style models (8 process-based, 8 preference-based and 3 cognitive-skills-based; see Table A4). It is beyond the scope of this paper to analyse this plethora of models. But an inspection of the style constructs listed shows how creative researchers have been in devising new frameworks to describe individual differences in learning (see Tables A1 – A4). With 56 models overall, how should practitioners choose among them in applying styles to course delivery particularly in higher education?

An attempt to identify the underlying dimensions of style measures was made by Bokoros and Goldstein (1992). These researchers factor analysed data from 143 university students and staff who completed five diverse style instruments comprising a total of 28 distinct indices, namely, Gregorc’s measure (see Table A1), Kolb’s measure (see Table A2), Christensen’s measure, Rowe and Mason’s measure and the Myers-Briggs Type Indicator (see Table A3). The results indicated that there are three common factors reflecting underlying dimensions: 1) thinking/feeling, 2) information processing, and 3) decision-making. Bokoros and Goldstein (1992, pp.5,8) argue against “the continued proliferation of instruments of limited applicability” in favour of new or modified measures which address underlying psychological processes.

A problem with many style measures is that they are just that, measures. Even among those measures which are highly reliable (on criteria such as Cronbach’s alpha), most lack construct validity, that is, they do not have a clear factor structure and/or do not measure actual behaviours apart from those involved in completing the measurement instrument. One example of how learning styles can be artefacts of a measuring instrument is given in Table 2 which compares results from studies by Brightman and Hightower (1989) and Carraher (1993). The first study used factor analysis of questionnaire data and identified four styles: pragmatic learning, discovery learning, critical inquiry and lack of commitment. But Carraher’s (1993) factor analysis of a different and larger set of data with the exactly same 13-item questionnaire yielded a completely different set of styles: problem solving, hands-on learning, intellectual learning and learning resource utilisation. Note that there is little overlap between the two studies in the items measuring the two sets of style construct (see Table 2). Clearly, both
sets cannot be valid and neither is likely to be truly reflective of real differences in learning behaviour.

### Table 2. Comparison of Learning Style Constructs in Two Studies Using the Same 13-Item Questionnaire

<table>
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<tbody>
<tr>
<td><strong>Style Construct</strong></td>
<td><strong>Items</strong></td>
</tr>
<tr>
<td>Pragmatic learning</td>
<td>1, 5, 11</td>
</tr>
<tr>
<td>Discovery learning</td>
<td>9</td>
</tr>
<tr>
<td>Critical inquiry</td>
<td>6, 10, 13</td>
</tr>
<tr>
<td>Lack of commitment</td>
<td>7, 8, 11</td>
</tr>
</tbody>
</table>

Although all of the style models have their advocates, several models seem to dominate the research literature relating to education, namely, Witkin’s (1964) field dependence/independence model, Kolb’s (1984) model, and Riding and Cheema’s (1991) integrated style model. These three models are now reviewed in detail.

#### 3.2. Field-Dependence/Independence Model

Witkin’s (1964) field-dependence/independence model has been described as “one of the most widely studied cognitive styles with the broadest application to problems of education” (Chen & Macredie, 2002, p.3). This model originated with experiments on human perception which tested an individual’s ability to judge the verticality of a rod encased in a frame set at various non-vertical angles (Witkin & Asch, 1948). This research indicated that individuals differ in the extent to which they are able to ignore (i.e., act independently of) the field surrounding an object. Field-dependence/independence is typically measured by the Group Embedded Figures Test (GEFT) which requires subjects to identify a simple shape embedded in a more complex field, the rationale being that those who are more field-dependent will find the task more difficult.

The single dimension of field-dependence appears to meet the style criterion of bipolarity (Messick 1984) in that it rates people from high to low on their level of dependence on field or context. However, it is definitely an ability rather than a preference, namely, the ability to process information independently of the context, a skill which is highly relevant to learning. Finally, the two styles field-dependence and field-independence are
the extremes on a continuous rather than a dichotomous dimension. Like most style models field-dependence/independence over-simplifies individual differences and typecasts people into categories.

3.3. Kolb’s Model

Another extensively researched model is that of Kolb (1984). This model proposes two orthogonal bipolar dimensions (viz., concrete experience [feeling] versus abstract conceptualisation [thinking]; active experimentation [doing] versus reflective observation [watching]) which yields four learning styles: accommodator, diverger, assimilator and converger (see Figure 2).

Figure 2. Kolb’s Model of Learning Styles

![Diagram of Kolb’s Model of Learning Styles]

Source: Kolb (1984). NB. Dashed lines are not part of Kolb’s model as proposed – see later discussion.

Kolb (1985) presents a revised version of his Learning Style Inventory originally developed ten years earlier. This simple 12-item instrument consists of statements such as “When I learn...” and “I learn best when...” covering different learning situations with four possible responses corresponding to the four learning styles. Respondents are required to rank the four sentence endings. Like its predecessor, this instrument has been criticised for its lack of construct validity which is thought to be due partly to its ipsative scoring method (viz., using ranking of responses which yields no absolute or relative information about individual differences) (Loo, 1996; Cornwall & Manfredo, 1994).
Although Kolb (1984) claims that his styles correspond closely with Jung’s psychological types, this has been questioned by Garner (2000) who points out that Kolb’s instrument has been found to explain no more than 20% of the variance in scores on the Jungian-based MBTI. Regarding whether Kolb’s model meets the style criterion of bipolarity (Messick 1984), there is mixed evidence. Using exploratory factor analysis Loo (1999) found some support for the existence of two bipolar dimensions. However, Geiger, Boyle and Pinto (1992) found that while there are two bipolar dimensions, these are not the ones proposed by Kolb but rather completely different ones (viz., those illustrated by the dashed lines in Figure 2). This inconsistent structure raises further doubts about the validity of the model. Finally, it is worth emphasising that individuals obtain scores on all four Kolb learning styles as would be expected considering that everyone uses all four abilities – thinking, feeling, doing and watching – albeit to different extents. It is simplistic and invalid, therefore, for Kolb and the adopters of his approach to typecast individuals on the basis of the one ability (i.e., alleged style) on which they score highest.

3.4. Riding’s Cognitive Styles Analysis

Riding argues that all the substantive approaches to cognitive styles (see Table A1) can be reduced to two primary dimensions (cf., Riding & Cheema, 1991). One dimension (wholist-analytic) indicates whether an individual processes information in wholes or in parts, whereas the other dimension (verbal-imagery) indicates whether a person relies more on verbal or visual representations of information. The Cognitive Styles Analysis (CSA) is an instrument which classifies individuals on these two binary dimensions by measuring response times to items assumed to be more readily processed by different styles (Riding, 1997). The ratio of response times is calculated for each dimension with individuals classified as ‘imagers’ versus ‘verbalisers’ and ‘wholists’ versus ‘analytics’ depending on whether their ratios are high or low on the two dimensions.

There are a number of problems with this framework. First, while Riding (1997) notes that the two style dimensions are continuous, individuals are categorised into distinct ‘groupings’ which are effectively types (viz., ‘wholist-imagers’, ‘wholist-verbalisers’, ‘analytic-imagers’ and ‘analytic-verbalisers’). Those whose CSA ratios are neither high nor low are classified as ‘bimodal’ on the verbal-imagery dimension and ‘intermediate’ on the wholist-analytic dimension and this gives rise to five additional groupings (Riding 1999; see his figure reproduced as Figure 3) but these groupings are largely ignored.
Riding asserts that his notion of style is different from ability:

The essential difference between them is that performance on all tasks will improve as ability increases, whereas the effect of style on performance for an individual will be either positive or negative depending on the task… For example, with the Verbal-Imagery style dimension, Verbalisers would find pictorial tasks more difficult than would Imagers, but they would find highly verbal tasks easier than would Imagers (Riding, 1999, p.5).

But Riding’s styles do not meet the Messick (1984) criteria for distinguishing styles from abilities (see Table 1). Riding’s (1999) claimed difference between his styles and abilities is simply an artefact of the method used to categorise people based on their CSA ratios. Specifically, verbalisers are those whose verbal ability is much greater than their imagery ability, and imagers are those who are much better at tasks involving imagery than verbal analysis. At best, Riding can claim that what is measured by the CSA is a pattern of ability, namely, a large differential in level on two abilities. Riding (1999) also claims that his notion of cognitive style is not related to intelligence. Again, this could be an artefact of the measure employed in that the CSA’s use of the ratio of two ability levels may neutralise the effect of intellectual difference.

Figure 3. Riding’s “Groupings of Cognitive Style”

Source: Riding (1999)
Next, let us consider the question of whether the CSA dimensions are bipolar as required by Messick’s (1984) criteria for styles vis-à-vis abilities (see Table 1). Riding and Rayner acknowledge this criterion when they say that the two ends of a style dimension “must represent opposites in some sense” but then they concede (unintentionally one assumes) that the CSA verbal-imagery dimension does not fully fulfil this condition by stating that “while words are not the opposite of pictures, they can be used as alternative ways of representing the same information” (Riding & Rayner, 1998, p.186; italics added). I would argue that the verbal-imagery dimension is not bipolar because it comprises two distinct unipolar dimensions of ability rather than the required bipolar preference dimension. Surely people have some level of ability to process verbal information and some level of ability to process visual information. If someone becomes more proficient at verbal processing they don’t necessarily become less reliant on visual processing as would be the case with a bipolar dimension. It follows, therefore, that the CSA’s verbal-imagery dimension is not a pervasive preference dimension that is both bipolar and value-differentiated as required by Messick’s (1984) criteria for a style rather than an ability.

Regarding the nature of the second CSA dimension (wholist-analytic), Riding and Rayner (1998, p.186) observe that “it is possible to see a progression from the whole to the parts. The whole is, in this sense, the opposite of the parts; the wood comprises the individual trees” (italics added). In other words, the wholist and analytic poles are ‘sort of but not really’ opposites (in the strict sense that hot/cold or agree/disagree are opposites) and thus the wholist-analytic dimension is not bipolar as required for a valid style construct. Also, it could be argued that this dimension does not clearly meet the Messick (1984) style criterion of relating to preference rather than ability (see Table 1), though it appears less of a pure ability measure than the visual-imagery dimension.

There are also serious doubts about the validity of the CSA. The main indication of this is the use of empirical data to define styles. For Riding ‘analytics’ are not people who exhibit a preference for processing information in a particular way, but rather those whose CSA scores (based on ratios of speed on analytic-versus-wholist type items) are in the top third of the distribution of scores. Similarly, for wholists, verbalisers and imagers as well as Riding’s other five intermediate ‘groupings’ depicted in Figure 3. But the cut-
offs in CSA scores used to define the various styles vary with the sample used as the benchmark (cf., Riding, 1998a versus Riding, 1998b) (see Table 3).

Consider, the case of ‘wholists’. If this style construct has validity then it must have surplus meaning beyond the statistical results of the CSA, that is, it must relate to actual information processing behaviour. Wholists are supposedly people who process information primarily by seeing the big picture. But for Riding (1998a, 1998b), they are those whose ratio on wholist-versus-analytic items is less-than-or-equal-to 0.90 (if benchmarked against the secondary school sample) or is less-than-or-equal-to 1.02 (if benchmarked against the broad sample which comprises primary, secondary and tertiary students as well as employed people) (see Table 3). In other words, the various CSA styles are artefacts of the instrument used to measure them and the practice of arbitrarily partitioning them in terms of 33.3% segments (see Table 3). If Riding wants to use a cut-off of ratio scores to differentiate the CSA styles then this should be based on behavioural differences apart from CSA performance. For example, it would be defensible to set the wholist:analytic cut-off at 1.0 on the grounds that this is the point at which subjects perform better (faster on the CSA) on analytic items than on wholist items, and then to allow plus-or-minus a specified margin to allow for ‘intermediates’. In any case, cut-offs for all style categories have to be defined in terms of behaviour not scores if they are to yield valid measures.

Table 3. Riding’s (1998a, 1998b) Classifications of Styles Based on CSA Scores: Comparison of Cut-offs from Two Empirical Samples

<table>
<thead>
<tr>
<th>Style Groupings</th>
<th>Secondary School Sample</th>
<th>Broad-based Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=2131 (Riding 1998a)</td>
<td>N=999 (Riding 1998b)</td>
</tr>
<tr>
<td>Wholist-Analytic Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wholists</td>
<td>Mean: 1.10 sd: 0.44</td>
<td>Mean: 1.25 sd: 0.45</td>
</tr>
<tr>
<td>• Intermediates</td>
<td>&lt;= 0.90</td>
<td>&lt;= 1.02</td>
</tr>
<tr>
<td>• Analytics</td>
<td>0.91 - 1.16</td>
<td>1.03 - 1.35</td>
</tr>
<tr>
<td></td>
<td>=&gt; 1.17</td>
<td>=&gt; 1.36</td>
</tr>
<tr>
<td>Verbal-Imagery Ratio</td>
<td>Mean: 1.11 sd: 0.28</td>
<td>Mean: 1.06 sd: 0.20</td>
</tr>
<tr>
<td>• Verbalisers</td>
<td>&lt;= 1.01</td>
<td>&lt;= 0.98</td>
</tr>
<tr>
<td>• Bimodals</td>
<td>1.02 - 1.14</td>
<td>0.99 - 1.09</td>
</tr>
<tr>
<td>• Imagers</td>
<td>=&gt; 1.15</td>
<td>=&gt; 1.10</td>
</tr>
</tbody>
</table>
Another problem with the CSA is that perennial practice in the style literature of treating continuous dimensions as discrete categories. Riding’s (1999) style groupings (see Figure 3) are highly questionable because the CSA measure itself shows that people’s scores differ along continuous dimensions (viz., the CSA ratios vary continuously above and below 1.0; see Table 3). While it may be acceptable to use a simplification of continuous individual differences by constructing a 3x3 matrix of categories for illustrative purposes as in Figure 3, it is invalid to treat these as nine distinct style types. Indeed, like most style researchers, Riding often reduces styles to binary dimensions using a simplified 2x2 version of his already simplified 3x3 matrix to yield four styles which stereotype 66.7% of learners and ignore the rest (cf., Riding, 1997, 1999).

4. The Nature of Style
4.1. Problems with the Style Construct
To summarise the above analysis, it has emerged that there are serious problems with the concept of style in the literature. As Messick observed almost two decades ago, “style research is peppered with unstable and inconsistent findings, while style theory seems either vague in glossing over inconsistencies or confused in stressing differentiated features selectively” (Messick, 1984, p.59). After reviewing the major models against the Messick criteria, Tiedemann (1989, p.261) concludes that “Sufficient empirical evidence of any cognitive style dimension in the sense of a bipolar, value-differentiated preference construct cutting across domains is lacking”. He further states:

The concept of cognitive style has been theoretically and empirically analysed for more than 3 decades now. But life is short, and so my personal opinion on the state of research into cognitive styles has to be: There is no point in chasing a chimera (Tiedemann 1989, p.273)!

I would argue that nothing has changed in the decade or so since Tiedemann’s (1989) assessment: the chimera has not metamorphosed into a credible creature! As has been shown in the previous analysis of three major style models, none of them can be regarded as meeting the Messick (1984) style criteria. The model advanced by Riding and his colleagues (Riding & Rayner, 1998; Riding, 1997; Riding & Cheema, 1991) can be treated as a test case for the validity and viability of the style approach considering that it attempts to provide an alternative to and integration of all other style models. The
conclusion from the present analysis, namely, that this integrated model is seriously deficient, must call into question the adequacy of the style construct.

Even if a style model does happen to satisfy all seven of Messick’s criteria (see Table 1), there is still the problem that style classifications over-simplify individual differences and reduce them to types. These types typically cover only those individuals whose scores on the relevant instrument fall at the extremes of the measured dimension, or even worse, whose moderate scores are grouped with those at the extremes on the basis of arbitrary cut-offs.

Styles may be like handedness insofar as they both refer to abilities as well as preferences but both may be determined by something more fundamental (presumably an inherited characteristic). Consider the basic cognitive style dimension of verbal-imagery which occurs in many of the style frameworks (see Table A1) and which Riding in various papers argues is one of the two fundamental cognitive styles, the other being wholist-analytic (e.g., Riding, 1999, 1997). All mentally competent individuals can process information both visually and verbally but vary in their preference for one over the other. Just as a right-handed person can throw a ball better with their right hand, an ‘imager’ can process information more quickly if it is presented in pictures rather than words. With handedness both ability and preference have to be assessed – people can vary in both their level of manual agility (from high to low) and also in their level of hand dominance (high preference for one hand through to equal preference). So too with style. People vary in their level of competence in both visual and verbal processing (from high to low on each). They also vary in their preference for one type of processing (again from a high preference for one mode through to equal preference for both).

4.2. An Alternative Perspective on Style: Model of Individual Differences in Learning
Based on the above analysis of styles, abilities and preferences, a new model is proposed to account for the effects of individual differences on learning outcomes. The model presented in Figure 4 is deterministic and follows the convention of using arrows to depict causal links. The constructs in the model can be operationalised as measurable variables and include the four types used in research (Sekaran, 2000), namely, dependent variables (see learning outcomes in model), independent variables (abilities), intervening variables (preferences, learning activities) and moderating variables (motivation, learning environment, learning materials).
Figure 4. Model of Individual Differences in Learning (incorporating constructs addressed by measures of style)

- Individual Abilities
- Individual Preferences
- Learning Activities
- Learning Environment
- Learning Outcomes
- Learning Materials

Constructs addressed by style measures
The starting point in the proposed model is the learner’s set of abilities which have their origins in the individual’s physical and psychological make-up (intelligence, personality etc). The central theoretical proposition is that one’s abilities are the primary determinant of one’s preferences which in turn determine one’s learning activities (see Figure 4). For example, if a person has high ability in visual processing and low verbal ability, they will prefer visual to verbal tasks and will prefer to engage in (and will also perform better at) learning activities that are visually rather than verbally based. Similarly, someone who is more socially proficient will prefer to engage in learning activities that involve interacting with others. Note that other influences on individual preferences are acknowledged in the model. In addition there is a feedback loop from learning activities depicted by the dotted lines in the model (see Figure 4). The proposition here is that increased engagement in specific learning activities improves one’s abilities in that behavioural area. For example, a learner who is better at concrete rather than abstract thinking will prefer to engage in non-abstract activities which further increase their competence in dealing with concrete examples.

The first moderating construct in the present model is motivation (and cognitive engagement) which is postulated to moderate the link between preferences and learning activities (see Figure 4). Thus, as a person’s level of energy and desire for learning varies, so will the likelihood that they will act on their preferences and engage in particular learning activities. The final set of relationships proposed in the model is that involving learning outcomes. The learning activities one engages in determine the learning outcomes achieved by the learner. However, this relationship is moderated by two constructs, learning materials and learning environment (see Figure 4). Here, matching is the key determinant factor. In the case of our high-visual/low-verbal learner, their learning activities will be more or less effective in producing outcomes depending on the relative visual and verbal nature of the learning materials and the learning environment (including delivery mode). Also, a socially proficient learner who prefers collaborative learning activities over solo activities will achieve more effective learning outcomes if the learning environment supports social interaction.

Further, the model posits that the impact of matching is moderated by motivation (as signified by the arrow from the motivation/engagement construct to learning outcomes – see Figure 4). This means that if an individual experiences a large mismatch between
their preferred learning activity and the actual learning environment and/or materials, they will still be able to achieve high learning outcomes provided their motivation/engagement level is high. In other words, learners who are highly motivated will be able to cope with large discrepancies between their preferred and actual learning situations, whereas those with low motivation will achieve lower learning outcomes if there are any mismatches between their preferred and the actual.

Finally, the model postulates that motivation/engagement arises from unspecified ‘other influences’ and is also partly determined by the learning environment (see links in Figure 4). In an online environment, for example, factors such as design of multimedia and level of learner control can affect a learner’s motivation (Najjar, 1998). Also shown in the model is a link between learning materials and motivation/engagement such that challenging content leads to increased cognitive engagement (Stoney & Oliver, 1999). The various causal links proposed in the model are empirically testable and can generate hypotheses for future research.

Where in the proposed model, it could be asked, is learning style? The answer is ‘nowhere’ – style is considered to be a superfluous construct. Following Sternberg and Grigorenko (1997) it is argued that the proliferation of style measures that have been advanced over the years (see Tables A1-A4) focus on one or more of three constructs: abilities, preferences and learning activities depicted in the model (see shaded boxes in Figure 4). However, as shown previously in this paper, measures of style are invariably based on attempts to simplify individual differences by reducing continuous variations in ability, preference or activity to discrete (usually binary) categories. Indeed, in many cases distinct dimensions are inappropriately treated as poles of a single dimension (Tiedemann, 1989).

For example, it has been noted above that the two dimensions of visual and verbal ability are regarded as a single bipolar dimension in several style models and measures including Riding’s consolidated model (Riding, 1999, 1997; Riding & Cheema, 1991). Even classifying people’s abilities as high-versus-low on these two dimensions is an over-simplification of continuous variability, whereas to consider them in terms of a single binary dimension is to impose an invalid typecasting system on the complexity of individual differences. This is clearly exemplified in Riding’s style classification of
individuals. As has been demonstrated above (see Section 3.4), his CSA instrument measures people on distinct continuous dimensions (visual and verbal) but uses the ratio between them to artefactually create two types (imagers versus verbalisers) based on arbitrary, indeed inconsistent, cut-offs (cf., Riding, 1998a, 1998b).

The model advanced here gives rise to a new definition of cognitive and learning style. *Styles are nothing more than type classifications of individual differences using arbitrary cut-offs along continuous dimensions in various abilities, preferences and learning activities. These differences which together are the major determinants of learning outcomes, can to some extent be accommodated by different learning strategies which maximise their compatibility with available learning materials and the learning environment.*

University teachers need to recognise individual differences and take account of them in designing and delivering curriculum. The over-simplification in terms of style may be beneficial if it helps teachers provide relevant variety and student choice. Where it becomes problematic is when students are typecast and treated differently according to their supposed style type.

5. **Issues in Higher Education**

5.1. **Styles research in a university context**

There is a widespread expectation that university education will increasingly adopt new information and communication technologies particularly in order to provide flexible or student-centred learning (NBEET, 1996; McClintock, 1999). Sensiper (2000, p.616), for example, claims that new technologies in the online environment at the Harvard Business School enable academics “to create multidimensional experiences that cater to different learning styles”. An important study of learning style was conducted by Smith and Woody (2000) who compared multimedia with traditional instruction in a university course. The results indicated that multimedia presentation offers benefits over lectures but only for students who are more visually than verbally oriented in their learning. These researchers note enthusiastically that “The good news is that the identification of these student characteristics may be quite simple” given the efficiency of the style classification test (viz., it takes only 5 minutes to administer) (Smith & Woody, 2000, p.223), but they refrain from suggesting that students should be ‘streamed’ into different
instructional groups on the basis of assessed visual-versus-verbal learning style. Rather they conclude that visual and verbal learners “might best be served by different strategies” and that “a combination of multimedia and traditional lecture approaches would be useful” (2000, p.223).

Some studies have failed to detect any effect of style differences on learning at tertiary level. For example, a study by Kraus, Reed and Fitzgerald (2001) investigated trainee teachers’ performance in a hypermedia-based course on behavioural disorders. There were no differences across trainees assessed in the four categories on the Kolb style model. These researchers also note that “Fitzgerald and Semrau (1997) concluded from their study that hypermedia learning environments provide equally effective instruction for users with different levels of field dependence/independence” (Kraus et al., 2001, p.136).

Ollerenshaw, Allinson and Kidd (1997) examined the effect of learning style on university students’ comprehension under different conditions of text supplementation of computer-based material. Using Biggs’s (1988) model of learning styles (surface, deep, achieving), this study found that with text-only presentation surface learners were much less efficient than other learners, but with multimedia presentation the different learning styles were not significantly different in effectiveness. The researchers speculate that the reason might be that “Because surface learners strategically balance their studies between working too hard and failing, it is possible that the computer simulation provides a means of learning the material without exerting too much effort” (Ollerenshaw et al., 1997, p.236).

Another example of university-based research is a study of achievement using the Tait and Entwistle (1996) style model (see Table A4) (Cassidy & Eachus, 2000). Deep and strategic approaches to learning were found to be associated with high academic self-efficacy and high self-confidence whereas surface and apathetic learning approaches were linked to low academic self-efficacy and low self-confidence.

5.2. Development of Styles
Throughout the literature across the various style models, there seems to be an assumption that a student’s style is a given and that university teachers and instructional designers should accommodate all styles equally. But this ignores the fact that styles are
differentially effective and that they vary in effectiveness across different learning environments (Busato et al., 1998). Also, if students are to be prepared for lifelong learning, there is an argument for developing in them the capacity to learn in diverse environments using a range of approaches, that is, a variety of styles. For example, rather than simply accepting that a high-visual/low-verbal learner (c.f., Rayner & Riding, 1997) will perform less well with verbal rather than visual material, should they not be encouraged to improve their verbal learning skills? Similarly, with deep-versus-surface styles (Tait & Entwistle, 1996), effective university teaching should surely aim to foster deeper learning strategies in students who habitually adopt a surface learning style. Not only are surface strategies less effective in learning but use of deep strategies has been found to lead to increased career success and job satisfaction (Busato et al., 1998). So too with the many other style dimensions covering the range of abilities and preferences relevant to higher education (see Tables A1-A4).

The development of learning styles in university students was investigated in a longitudinal study by Busato et al. (1998) who used Vermunt’s (1998) model which distinguishes four learning styles: undirected (unable to organise and prioritise study material), reproduction directed (aimed at passing exams by reproducing learned material), application directed (focused on applying material to real-world situations), meaning directed (aimed at understanding material and inter-relating material). Vermunt’s instrument does not simply categorise but assesses students’ use of all four styles although the highest score is taken to indicate the dominant style. Not all styles are assumed to be equally effective. Indeed, the meaning-directed and application-directed styles are regarded as superior and to be encouraged in students. Also, there is evidence that the undirected style is negatively related to academic success (Busato et al., 1998). The results of this longitudinal study indicated that over several years, students made less use of the undirected and reproduction-directed learning styles and more use of the application-directed and meaning-directed styles. However, the investigators conclude that while “students should ‘learn to learn’, … to adapt education at the universities based on the learning style theory of Vermunt seems rather too early” (Busato et al., 1998: 439).

Schellens and Valcke (2000, p.382) argue that “If learning styles are – in part – the product of the learning environment, then a successful learner will adapt to the appropriate/ preferred learning style”. Riding and Rayner discuss two strategies which
learners can use to extend their style, namely, translation and adaptation. “Translation involves recasting the information which as presented may be in a form that does not suit an individual’s style, into a mode that makes it easier to process and understand” (Riding & Rayner, 1998, p.93). Thus, a person who is more proficient with verbal processing may use words to describe a picture, and a big-picture individual (wholist) may list the headings in a book chapter to identify its structure. The related strategy of adaptation “is where a style dimension is pressed into service because a feature is not available on the other dimension of an individual’s style” (Riding & Rayner, 1998, p.94). While Riding and Rayner present these as compensatory strategies, they could be seen as providing a developmental benefit for a learner enabling them to work more effectively in a broader range of learning environments.

5.3. Styles Implementation by University Teachers and Students
So how should styles be implemented at university level? A clear implication of the present analysis is that typecasting should be avoided. As we have seen the styles movement is founded on the over-simplification of individual differences – continuous variations in abilities and preferences are typically treated as distinct types belonging to arbitrarily discrete categories. Research on styles generally compares learners who are at the extremes of the relevant continuous dimension. Although there is considerable evidence of differences on the many ability and preference dimensions, there are no clear-cut indications that educators should implement either tailoring or streaming.

‘Tailoring’ refers to the practice of designing and delivering courses so that they are matched to the style of the learner. There is substantial research evidence that learners perform better in matched rather than mismatched situations (Chen & Macredie, 2002; Ford & Chen, 2001; Martinez, 2001; Ford, 2000). Should educators, therefore, tailor course delivery on the basis of the learner’s style? In particular, should hypermedia packages be designed to cater for a variety of styles or even employ intelligent agents to adjust automatically to a learner’s assessed style as advocated by some (e.g., Maule, 1998)?

Despite the evidence that matching affects learning effectiveness, there are problems with implementing a tailoring program. The first problem is that of choosing a style model. Which of the more than 50 style models is the most appropriate? On what basis, for example, should one choose the field-dependence/independence model over the
serialist/holist model when both have research evidence of superior learning under matched conditions (Chen & Macredie 2002 and Ford 2000, respectively). An even more significant problem is that of tailoring learning packages to the broad range of learners and not only to those at the extremes of an ability/preference (style) dimension. Another problem is that of getting beyond the hype to develop specific packages that cater for relevant individual differences in a manner that actually improves learning outcomes.

The related concept of ‘streaming’ refers to assigning students to different learning conditions (e.g., separate classes or separate learning environments) on the basis of their assessed/presumed style. Such a practice cannot be justified at university level (indeed at any educational level) for a number of reasons. First, it is likely to be discriminatory and possibly illegal in many jurisdictions for it denies some students access to learning resources provided to other students. Streaming is also inappropriate because it is based on stereotyping students according to their differences in abilities and preferences. Further, this approach assumes that students who have low ability levels on a particular style dimension are incapable of developing competence in that area and are then denied an opportunity for doing so.

Do styles have anything to offer university educators? There is no doubt from the literature that many of the style instruments (see Tables A1-A4) provide a basis for assessing differences which are relevant to learning at all levels. It is argued that some of these diagnostics have practical value in higher education provided typecasting is avoided and the results are seen as yielding simplified information about individual differences in abilities and preferences that affect learning outcomes (see model depicted in Figure 4). In particular, style instruments such as those reviewed in this paper, can be used to create awareness of individual differences which are relevant to learning. Such awareness serves several key purposes. First, it gives students insight into their strengths and weaknesses across learning-related dimensions. Second, awareness gives academics a perspective on how different students approach learning and also on their own information processing abilities and preferences which determine their approach to teaching. Third, awareness of differences can help students in interactive and collaborative learning situations (such as group projects and tutorials on-campus and in chat rooms and discussion boards online) where other students may well have a different learning approach from their own. Fourth,
in student-teacher interaction mutual awareness of differences should improve the effectiveness of communication.

Dede (2001) sees the future of education as likely to be based on ‘distributed learning’ which involves using a variety of instructional media incorporating new information technologies, and ‘knowledge networking’ where people create and share knowledge in virtual communities. He argues that “well-designed courses using several instructional media with differing characteristics and affordances (for example, synchronous vs. asynchronous, high bandwidth vs. low bandwidth, contextualized vs. decontextualized) let all students use their most effective learning techniques” (Dede, 2001, pp.23-24). This approach appears to acknowledge that there are individual differences in abilities and preferences but doesn’t place students into distinct style categories that have to be exclusively catered for by tailoring delivery to match the different de facto types. By offering a variety of media with different features and ‘affordances’, Dede (2001) argues, each learner is able to ‘find their voice’ by concentrating on the media that they find empowering and avoiding those they find disenfranchising.

6. Summary and Conclusion
This paper set out to critically review the literature on styles. It has been shown that the style construct has a long history in the behavioural sciences and is now thoroughly entrenched in educational theory and research. There have been several distinct traditions in style research, variously categorised as comprising personality-based, information-processing-based and instructional-preference-based (Curry, 1983) or as comprising cognition-centred versus learning-centred style models (Riding & Rayner, 1998). While these research traditions have dominated at different times they all now constitute the style literature and collectively represent a vast and muddled landscape. The terms ‘cognitive style’ and ‘learning style’ are used inconsistently throughout the literature.

This review adopted Messick’s (1984) criteria for distinguishing styles from abilities although it was shown that Messick himself was not always clear in his conceptual analysis. In addition to the 30 style models classified by Rayner and Riding (1997), this paper has identified a further 26 models and their sources (see Tables A1-A4). Three of the models widely used in research have been subjected to detailed analysis, the field-dependence/independence model, Kolb’s model and Riding’s (1997, 1999) integrated
model. All three have been shown to have serious deficiencies including lack of bipolarity and lack of construct validity. All three were shown to measure abilities rather than styles and to typecast individuals by treating continuous differences as discrete categories. Riding’s model which is claimed to integrate and in effect replace other models, was also shown to categorise people using arbitrary cut-offs with no valid conceptual basis.

A new model of learning has been proposed (see Figure 4) to account for the effects of individual differences. The model accommodates the constructs addressed in the various style models (viz., abilities, preferences and learning activities) and demonstrates that the style construct is superfluous for an understanding of the learning process. A new definition of style has been advanced (see Section 4.2) which captures the true nature of the construct in its various forms in the literature.

In the area of higher education, this review has indicated that there are problems with the implementation of styles in a university context. It has been argued that educators have an obligation to develop the capacities of students. Instead of accepting styles as locked-in and simply catering for them in some way, academics would do better by their students to encourage their development in all learning-relevant abilities and thereby enable them to learn effectively in a variety of environments with a variety of learning materials.

In conclusion, it is argued that style models do have a place in higher education provided they do not result in typecasting. It has been shown that there is no place for streaming students into separate learning environments on the basis of style type. Some style instruments have value in improving awareness among both academics and students of individual differences which affect learning and teaching. Generally, academics need to be mindful that students differ in how they respond to different learning situations, not because they are of different style types but because they vary continuously in their abilities and preferences. It is only by using a wide variety of instructional media incorporating new instructional technologies that academics can accommodate the needs of different learners.
References


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Rayner, S., & Riding, R. 1997, Towards a categorisation of cognitive styles and learning styles, *Educational Psychology, 17*(1/2). http://ezproxy.usq.edu.au:2354/citation.asp?tb=1&ug=dbs+0+fic+0+in=en%2DUs+sid+CD3A6636%2D21C0%2D4D56%2DAFFA%2D9E8523C5E7E6%40sessionmgr3%2Dsessonmgr4+616


## APPENDIX

### Table A1. Rayner & Riding’s (1997) List of 18 Cognitive Style Constructs

<table>
<thead>
<tr>
<th>Key Dimension</th>
<th>Style Construct</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholist-Analytic</td>
<td>Constricted-flexible control</td>
<td>Klein (1954)</td>
</tr>
<tr>
<td></td>
<td>Broad-narrow</td>
<td>Pettigrew (1958)</td>
</tr>
<tr>
<td></td>
<td>Analytic-non analytic</td>
<td>Messick &amp; Kogan (1963)</td>
</tr>
<tr>
<td></td>
<td>Levelling-sharpening</td>
<td>Klein (1954)</td>
</tr>
<tr>
<td></td>
<td>Field dependence-independence</td>
<td>Witkin &amp; Asch (1948)</td>
</tr>
<tr>
<td></td>
<td>Impulsivity-reflectiveness</td>
<td>Kagan et al. (1964)</td>
</tr>
<tr>
<td></td>
<td>Cognitive-complexity</td>
<td>Harvey et al. (1961)</td>
</tr>
<tr>
<td></td>
<td>Automisation-restructuring</td>
<td>Tiedemann (1989)</td>
</tr>
<tr>
<td></td>
<td>Converging-diverging</td>
<td>Hudson (1966)</td>
</tr>
<tr>
<td></td>
<td>Serialist-holist</td>
<td>Pask &amp; Scott (1972)</td>
</tr>
<tr>
<td></td>
<td>Splitters-lumpers</td>
<td>Cohen (1967)</td>
</tr>
<tr>
<td></td>
<td>Adaptors-innovators</td>
<td>Kirton (1976)</td>
</tr>
<tr>
<td></td>
<td>Concrete sequential / concrete random / abstract sequential / abstract random</td>
<td>Gregorc (1982)</td>
</tr>
<tr>
<td></td>
<td>Reasoning-intuitive active-contemplative</td>
<td>Allinson &amp; Hayes (1996)</td>
</tr>
<tr>
<td>Verbal-Imagery</td>
<td>Abstract-concrete</td>
<td>Harvey et al. (1961)</td>
</tr>
<tr>
<td></td>
<td>Tolerance for unrealistic experiences</td>
<td>Klein et al. (1962)</td>
</tr>
<tr>
<td></td>
<td>Verbaliser-visualiser</td>
<td>Paivio (1971)</td>
</tr>
<tr>
<td>Both</td>
<td>Analytic-wholist and verbal-imager</td>
<td>Riding &amp; Cheema (1991)</td>
</tr>
</tbody>
</table>

NB. See Rayner & Riding (1997) for detailed references
<table>
<thead>
<tr>
<th>Key Dimension</th>
<th>Style Construct</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process-based</td>
<td>Meaning orientation / reproducing orientation / achieving orientation / holistic orientation</td>
<td>Entwistle (1979)</td>
</tr>
<tr>
<td></td>
<td>Surface-deep-achieving orientation / intrinsic-extrinsic-achievement orientation</td>
<td>Biggs (1978)</td>
</tr>
<tr>
<td></td>
<td>Synthesis-analysis / elaborative processing / fact retention / study methods</td>
<td>Schmeck et al. (1977)</td>
</tr>
<tr>
<td></td>
<td>Concrete experience / reflective observation / abstract conceptualisation / active experimentation</td>
<td>Kolb (1976)</td>
</tr>
<tr>
<td></td>
<td>Activist / theorist / pragmatist / reflectors</td>
<td>Honey &amp; Mumford (1986)</td>
</tr>
<tr>
<td>Preference-based</td>
<td>Environmental / sociological / emotional / physical / psychological</td>
<td>Price et al. (1976); Dunn et al. (1989)</td>
</tr>
<tr>
<td></td>
<td>Participant-avoidant / collaborative-competitive / independent-dependent</td>
<td>Riechmann-Grasha (1974)</td>
</tr>
<tr>
<td></td>
<td>Visualisation / verbal symbols / sounds / emotional feelings</td>
<td>Reinert (1976)</td>
</tr>
<tr>
<td></td>
<td>Linguistic symbols / cultural determinants / modalities of interference / education memory</td>
<td>Hill (1976)</td>
</tr>
<tr>
<td></td>
<td>Cognitive skills / perceptual responses / study and instructional preference</td>
<td>Keefe &amp; Monk (1986)</td>
</tr>
</tbody>
</table>

Table A2. Rayner & Riding’s (1997) List of 12 Learning Style Constructs
<table>
<thead>
<tr>
<th>Key Dimension</th>
<th>Style Construct</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholist-Analytic</td>
<td>Analytic-heuristic</td>
<td>Huysmans (1970)</td>
</tr>
<tr>
<td></td>
<td>Extraversion-introversion / sensing-intuition / thinking-feeling / judgement-perception</td>
<td>Briggs &amp; Myers (1977)</td>
</tr>
<tr>
<td>Verbal-Imagery</td>
<td>Verbalizer-visualizer</td>
<td>Richardson (1977)</td>
</tr>
</tbody>
</table>
Table A4. List of 19 Additional Learning Style Constructs Identified in the Present Review

<table>
<thead>
<tr>
<th>Key Dimension</th>
<th>Style Construct</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mastery / understanding / self-expressive / interpersonal</td>
<td>Silver, Strong &amp; Perini (2000)</td>
</tr>
<tr>
<td></td>
<td>Processing / regulation / mental models / learning orientations</td>
<td>Vermunt (1998)</td>
</tr>
<tr>
<td></td>
<td>Separate knowing / connected knowing</td>
<td>Gallotti et al. (2001)</td>
</tr>
<tr>
<td>Preference-based</td>
<td>Transforming orientation / performing orientation / conforming orientation /</td>
<td>Martinez (2000)</td>
</tr>
<tr>
<td></td>
<td>resistant orientation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conditions for learning / area of interest / mode of learning / expectation for</td>
<td>Canfield (1988)</td>
</tr>
<tr>
<td></td>
<td>course grade</td>
<td></td>
</tr>
<tr>
<td></td>
<td>commitment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Problem solving / hands-on learning / commitment to intellectual learning /</td>
<td>Carraher (1993)</td>
</tr>
<tr>
<td></td>
<td>learning / learning resource utilization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pacing / influence over learning / media / active role / feedback</td>
<td>Friedman &amp; Stritter (1976)</td>
</tr>
<tr>
<td>Key Dimension</td>
<td>Style Construct</td>
<td>Source</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
</tbody>
</table>