JISC e-Learning Models Desk Study

Stage 2: Learner-centred pedagogy: Individual differences between learners

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1. Learner-centred pedagogy: introduction

In *Review of e-learning theories, frameworks and models* we described the three broad theoretical strands that have shaped the development of pedagogical principles in the design of technology-enhanced learning environments. Each of the theoretical frameworks can be characterised as providing a model of an ideal learner, choosing to focus its explanation on identifiable but particular aspects of learning behaviour. Thus, the associationist tradition models the learner primarily as a set of skilled responses, the cognitive approach as a constructor of meaning, and the situative strand pictures learners mainly as social agents. Of course, a learner is all of these at once and, as we concluded, the growing sophistication of pedagogical practice in HE and FE is arguably integrating each perspective into a kind of modal view. However, the lens through which the learner is viewed at any particular point, and thus the model adopted along with its associated pedagogical approach, will be determined at least partly by the nature of the intended learning outcomes (ILOs) and the way in which they are to be assessed. This description of the goals of a curriculum will convey underlying assumptions about the kind of behaviour being brought into focus, ie skilled performance, deep understanding or effectiveness of practice. Right from the initial point of defining ILOs an underlying model of the learner will emerge, a corresponding tradition of theory will be implied, and a pedagogical approach suggested.

This theoretical 'big picture' does not by any means tell the whole story. Embedded within the pedagogical approach adopted will be procedures for dealing with individual variation. This is usually what we imply by the term 'learner-centred': adjusting our teaching and learning activities in ways that take account of individual needs[1]. This is one of the main challenges in teaching. It is worth pointing out, as Biggs (1999) has done, however, that while there are good pedagogical reasons for attending to the way in which learners differ, there are also dangers in labelling students as resistant to teaching. It is important to go beyond merely noting that some students learn more readily than others to try to understand the nature of the difference and to build this understanding into the pedagogy itself. Identifying the source of the variation will influence the way in which it is accommodated. Thus, the source may be 'hard-wired' in the constitution of the learner, it may stem from previous learning, or it may emerge during the learning process itself.

Let us take the example of students who attend at the start of an academic session for ICT training. In order to teach them efficiently, we need to discover what they already know and can do with the software in question, we need to know how quickly they are going to be able to acquire the new skills, and we need to know how willing they are to attend the computer lab and how much practice they are willing to do in their own time. We should model these learners not just as performers of practice-based skills, as understanders of principles, or as representatives of a social group of first year students (ie giving importance to one or more of the broad perspectives that will determine the pedagogical approach), but also as individuals with a particular value on each of these implied dimensions. If we now take a further step and seek understanding of *why* a particular learner is at a particular point of knowledge or skill, or has a particular kind of ability, or a particular level of motivation, then we begin to seek the development of a theory of *individual* pedagogy: the design of the process of aligning *for an individual learner* teaching and learning methods with outcomes. Their prior experience determines both their starting point and the speed with which they improve, their ability also influences both of these, and their motivation to apply themselves to practice (which itself will be subject to influences from all kinds of sources, including their social environment) will also determine their progress. In most HE and FE contexts a standard curriculum is taught in a standard form and individual differences in ability, prior knowledge or motivation are catered for in the kind of feedback and support given to individuals. There is, however, increasing interest in using self-assessment

[1] In practice the term 'learner-centred' has lost most of its meaning: institutions will describe themselves as 'learner-centred' even where their practice is almost entirely teaching-centred, ie where a standard curriculum is 'delivered' to large numbers of learners, each of whom will receive minimal feedback on individual performance.

(Gibbs, in press) to cater for such differences in the student group. The concept of individualised instruction has long been a key theme for educational technology and much development work has been aimed at finding ways of varying learning materials along dimensions of difficulty that can be matched to individual progress. Indeed, this was a key objective of programmed learning and later of intelligent tutoring systems.

Today, a real learner-centred approach can be seen in skills-based courses, where it clearly doesn't make sense to give the same instruction to all students and the support given will be determined by performance on an initial diagnostic test, and by regular assessments. But in such cases, eg ICT skills or communication-skills courses, it can be readily acknowledged that students differ both in ability, prior knowledge and motivation. In standard programmes these assumptions cannot really be explicitly recognised, since selection on prior educational achievement is assumed to iron out most if not all such differences. The introduction of PDP can be expected to breathe new life into the debate about how the introduction of technology can help us to cater for individual differences between learners.

2. Abilities and Learning Differences

Through the long history of the literature of learning and individual differences, ability theories developed to encompass a general concept of intelligence (Spearman 1923), specific ability notions of intelligence (Guilford 1985), and then information-processing approaches to cognitive ability (Sternberg 1985). For a long time, researchers into individual differences in learning simply assumed that they were all consequences of a single fundamental ability: that intelligence *was* the ability to learn. To ask whether learning is influenced by ability seemed a circular question. General ability was defined by an individual's comparative performance on various tasks, mostly involving problem solving under time stress. In so far as these predicted an individual's capacity to understand a task, and to find an appropriate strategy to achieve a solution, then they also predicted that individual's performance on most learning tasks. Nevertheless, it became clear that factors other than general ability will also influence learning. There was a gradual reconsideration of the unitary theory of intelligence, leading towards a view that learning is domain specific.

By 1988, Ackerman was able to describe individual differences in learning in the following way:

• We no longer believe that intelligence is unitary: it is unlikely that a single learning ability exists.

• We no longer consider all types of learning to be alike.

• We no longer assume that intelligence and learning are different names for the same construct.

2.1. MAINSTREAM PSYCHOMETRIC APPROACH TO ABILITY

Within the mainstream psychometric approach to ability three levels of intellectual ability were identified. General mental ability (G) was broken down into the second-order abilities of fluid, crystallised and visual ability (e.g. Cattell 1971). A third level then attempted to identify through the technique of factor analysis a list of 'primary' mental abilities. By the time Guilford published his 150-ability cube (Guilford 1985), however, the specific abilities approach no longer seemed more helpful than the unitary-ability model.

A number of attempts have been made to relate the second-order level of ability to pedagogy. One of the most systematic was Snow and Swanson's (1992) description of second-order abilities from the perspective of instructional psychology. *Fluid analytic reasoning (Gf)* was regarded as being particularly involved in learning situations that aim at flexible, abstract and innovative learning goals. An important question for the purpose of education and training policy is whether G_f can be trained. There are some claims in the literature that this can indeed be achieved (see Snow and Swanson 1992). *Visuo-Spatial Ability* (G_V) represents the ability to visualise and manipulate visual-spatial objects, imagine spatial situations from different viewpoints, and to identify figures and objects in fragmented or degraded forms. This ability is important in many vocational domains. Interestingly, there are also several recent claims for the trainability of G_V, including approaches which have employed computer graphic techniques. The goal is to understand

when to capitalise on G_V, and when, for some learners, to circumvent it. *Crystallised Verbal Abilities* G_C describes a constellation of abilities centred around reading and vocabulary skills and general verbal knowledge (Hunt 1985). These are certainly trainable and much formal education is directed at that goal. Finally, there is considerable evidence to include *Perceptual Speed and Psychomotor Ability* in the list of secondary mental abilities; several studies have demonstrated that perceptual speed is an ability separate from visuo-spatial (Lohman 1989).

2.2. COMPLEXITY MODELS OF INTELLIGENCE

We have seen more recently the emergence of complexity models of intelligence which assume that intelligence is an interacting set of abilities. Gardner's 1983 theory of multiple intelligences suggests that there are a number of distinct forms of intelligence that each individual possesses in varying degrees. Gardner proposes seven primary forms: linguistic, musical, logical-mathematical, spatial, body-kinesthetic, intrapersonal and interpersonal. Recently, Gardner has added naturalist intelligence to expand his model to eight different forms. Gardner has argued for specific pedagogies to be developed to allow each of the abilities to be expressed, and he points out that the different intelligences represent not only different content domains but also learning modalities. Gardner also emphasizes the cultural context of multiple intelligences.

Gardner (1983, p 390) describes how learning to program a computer might involve multiple intelligences: *"Logical-mathematical intelligence seems central, because programming depends upon the deployment of strict procedures to solve a problem or attain a goal in a finite number of steps. Linguistic intelligence is also relevant, at least as long as manual and computer languages make use of ordinary language...an individual with a strong musical bent might best be introduced to programming by attempting to program a simple musical piece (or to master a program that composes). An individual with strong spatial abilities might be initiated through some form of computer graphics -- and might be aided in the task of programming through the use of a flowchart or some other spatial diagram. Personal intelligences can play important roles. The extensive planning of steps and goals carried out by the individual engaged in programming relies on intrapersonal forms of thinking, even as the cooperation needed for carrying a complex task or for learning new computational skills may rely on an individual's ability to work with a team. Kinesthetic intelligence may play a role in working with the computer itself, by facilitating skill at the terminal..."*

3. Matching pedagogy to ability

The idea of matching pedagogy to the ability profile of an individual learner is addressed directly in the work of Snow and his co-workers. Cronbach & Snow (1977) developed the approach known as *Aptitude-Treatment Interaction (ATI),* the aim of which is to predict educational outcomes from combinations of aptitudes and instructional strategies (treatments). As a theoretical framework, ATI is consistent with theories of intelligence that suggest a multidimensional view of ability. Snow (1989) reported that the best supported ATI effect involved treatments that differed in the structure and completeness of instruction and high or low 'general' ability measures. Highly structured treatments (e.g. high level of external control, well-defined sequences/components) seem to help students with low ability but hinder those with high abilities (relative to low structure treatments).

In his work, Snow expanded the definition of aptitude from the conventional cognitive-based strategies and abilities, to include *conative* (motivational and volitional) and *affective* aspects of learning. With this much wider view of aptitude, Snow's "aptitude-complexes" theory accounted for the interaction between an individual's personal aptitudes (e.g. experience, motivation, ability, knowledge, and regulatory processes) and situational demands. Over time, these dynamic relationships may change as new aptitudes are applied and/or the tasks altered. Most ATI studies have focused on the predictive power of aptitudes to assign learners to different treatments. Typically, this kind of research begins with conventional psychometric measures, such as crystallised intelligence or spatial ability, and tries to relate these to variations in some kind of instructional method. Often innovative instructional methods have been employed, involving meta-

cognitive methods, participative modelling, reciprocal teaching, or anxiety reduction methods. While preliminary findings of Aptitude x Treatment Interaction found mixed results, recent research has yielded more positive findings (Kyllonen & Lajoie, 2003).

In one sense, any kind of tutoring involves trying to understand ATIs. A tutor may switch between mastery-style direct instruction, and guided discovery, contingent on their perception of student differences. Little is understood about this process but, as Snow and Swanson point out, good tutors seem able to adapt both to the specific progress made by the learner on the task being taught, and to the more general aptitudes revealed by the learner. However, Jonassen and Grabowski (1993) conclude that ATI research lacks consistency and generality. They concur with the comment made by Bond & Glaser (1979) that ATI research was *"mostly A and T and not much I"*.

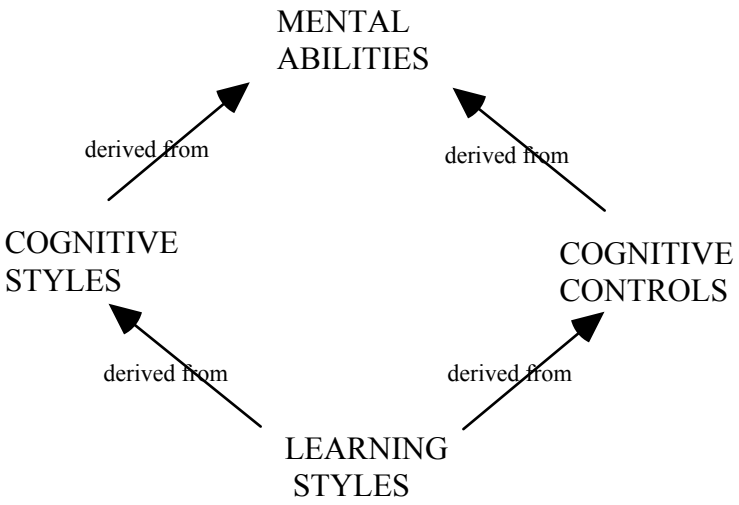
Recently, however, ATI work has begun to be applied to e-learning. Shute has studied a number of ATIs and has taken the ideas into the e-learning field. Shute and Towle (2003) argue that e-learning will become greatly more effective as *learning objects* become adaptive to the learners' profile of aptitudes (adopting Snow's inclusion in the measure of aptitude both prior learning and motivation), both in a domain-dependent and domain-independent way. Shute and Towle (2003) review a specific system—Student Modeling Approach for Responsive Turoring (SMART)—which is capable of guiding the selection of learning objects to fit the immediate needs of the learner. SMART is a student modeling system that selects learning objects according to its estimate of how much a student knows and how fast a student is learning. It estimates learning speed based on two sources of a student's learning history. One source is how quickly a student is learning in the particular learning session. The approach of a computer reacting to this kind of information is called *microadaptive.* The other source is how quickly a student learns on average, or in general, not just in this session (e.g., based on how well a student performs on a separate learning task). The approach of a computer taking advantage of this kind of information is called *macroadaptive.* Combining microadaptive and macroadaptive approaches to estimate a student's current knowledge and learning speed, the SMART system selects appropriate learning objects for a particular learner at a particular moment in the instructional session.

The view of aptitude that emerges from this line of work, encompassing specific abilities, motivation and affect, is closely related to the concept of cognitive style, the characteristic ways in which people make use of their intellectual abilities. Global theories of style, beginning with Myers's (1980) typology, identify characteristic styles of thinking that permeate many aspects of the way a person interacts with the world. More specific theories focus on a narrower range of behaviour (for example, the authoritarian style). Cognitive styles are individual differences that lie in a conceptual grey area somewhere between intelligence and personality. It is sometimes impossible to distinguish between what is a personality dimension and what is a cognitive style (Sternberg & Ruzgis, 1994).

4. The Construct of Learning Style

The construct of learning style has attracted a great deal of attention in recent years, both for its popularity with practitioners and for its unpopularity with some researchers into pedagogy. A framework for relating this complex topic to the work on abilities, reviewed above, has been offered by Jonassen and Grabowski (1993). Combinations of mental abilities comprise cognitive controls. These, in turn, define cognitive styles. At the most general level of all lie learning styles. Their relationships are shown as follows:

Figure 5.4: Individual styles



4.1. COGNITIVE CONTROLS

A reasonably comprehensive list of cognitive controls would include the following:

• Field Dependence/ Independence (Global v Articulated Style)

• Cognitive Flexibility (Constricted v Flexible Control)

• Impulsivity/ Reflectivity (Cognitive Tempo)

• Focal Attention (Scanning v Focusing)

• Category Width (Breadth of Categorising)

• Cognitive Complexity

• Automisation

Cognitive control theory is very close to that of cognitive style, but Jonassen and Grabowski (1993) follow the distinction made by Messick (1986), in treating cognitive control as a separate category of ability. Without imposing structure of this kind then, as Snow and Swanson note, discussions of cognitive style simply involve lengthy and disorganised lists of constructs.

Cognitive controls are derived from primary abilities, but are specifically concerned with the manner and form of learning. They are described in terms of typical behaviour. They are descriptions of information-processing techniques, as are cognitive styles, but they emphasise control rather than facilitation. They also differ from cognitive styles in being unipolar. For example, reflective processing is likely to be effective in learning situations, while impulsive processing isn't.

Field Dependence/ Independence has the largest literature devoted to it. FD/I attempts to measure the extent to which the learner's perception is affected by context. Field dependents will find it difficult to locate the information they are seeking because it will be masked by other information in the search field. FD/I is closely related to the concept of global v articulated cognitive style. FD's have a global cognitive style because they are more likely to allow external cues to determine their understanding. FI's will have an articulated cognitive style, preferring to create their own framework of understanding. The empirical evidence summarised by Jonassen and Grabowski (1993) suggests that FI learners will more effectively cope with searching for and selecting target information, evaluating relevance, creating structure for themselves, and transfer of knowledge to new situations.

Most of the cognitive control measures in the list above seem closely related to FD/I and there seems no good reason for regarding them as separate components. In general, researchers have sought to construct original tests which succeed in predicting performance differences on other learning tasks, and have simply adopted a new term for the measure without any rationale for supposing that the new test is revealing a previously undiscovered aspect of ability. There is circularity of reasoning here. Individual differences in the performance of certain tasks are noted, and are used to predict individual differences in other, related tasks. What has been explained? This is not just a problem with measures of cognitive control of course. The usefulness of any ability construct must be tested by its power to predict an individual's performance in real learning. Thus, unless we have a way of relating abilities and tasks in an explanatory framework, isolated constructs such as cognitive controls will remain of limited value.

4.2. COGNITIVE STYLES

Cognitive styles are descriptions of characteristic and stable approaches adopted by individuals in acquiring and organising information. They are widely employed constructs, despite a lack of strong empirical support, and their adoption by influential scientists such as Pask (1976a; 1976b) and by educationalists, such as Entwistle (1981), has lent considerable authority to their use.

The classification offered by Jonassen and Grabowski is as follows:

Cognitive Styles: Information Gathering

Visual / Haptic

Visualiser / Verbaliser

Levelling / Sharpening

Cognitive Styles: Information Organising

Serialist / Holist

Conceptual Style (Analytical / Relational)

The two most discussed versions of cognitive style are those of Visualiser / Verbaliser, and Serialist / Holist.

Visualiser / Verbaliser

The idea that some individuals prefer to attend to and process information in the form of graphics, diagrams or illustrations, rather than through words, has been a popular and persistent construct. Richardson (1977) built on the work of Paivio (1971) in attempting to understand the respective roles of visual and verbal processes in learning. Richardson correlated lateral eye-movements with responses on Paivio's "Ways of Thinking" questionnaire. He identified items which discriminated reliably between left (visualisers) and right (verbalisers) eye movers. Later work (Kirby, Moore, and Shofield 1988) has found only moderate correlation with measures of visuo-spatial ability, and there has been little research relating this style to real learning.

Serialist / Holist

Pask (1976) and Pask and Scott (1972) studied patterns of conversations between learners. They employed entailment meshes, evolutionary graphical frameworks of concepts, to represent the development of shared concepts among individuals. Through these, different patterns of thought could be identified among learners. They developed CASTE (the Course Assembly and Tutorial Environment), a computer-based tutorial system. From the data collected with this, the learning and thinking strategies became apparent, and the holist/serialist distinction was derived. Holists use a thematic or global approach to learning by developing broad descriptions. In contrast, serialists use an "operations" approach, concentrating more

narrowly on details and procedures before building a big picture. Typically they will work "bottom-up" in developing simple, linearly-ordered links in a logical structure. Holists, on the other hand, were described by Pask as tending to work "top-down" but not focusing sufficiently on detail, through "globetrotting".

Although this treatment of cognitive style has been much discussed, as with the visualiser/verbaliser dimension, there is so far little evidence for its usefulness in instructional settings. Effective learners will probably employ both holist and serialist strategies.

4.3. LEARNING STYLES

Finally, in this section we consider the so-called learning styles which, as Jonassen and Grabowski point out, essentially represent attempts to specify cognitive styles that have particular relevance in applied learning environments. All of these are based on self-reports of preferences in learning. The validity of these rests largely on the assumption that learners have insight into, and awareness of, their own learning processes.

In a recent major review of the literature on learning styles Coffield et al (2004) identified 71 models of learning styles from which they were able to select 13 major models, with their associated measuring instruments, for analysis. They further classified these into five 'families' along a 'fixedness' dimension.

The classification (with the summary assessments) was as follows:

- **Constitutionally-based learning styles and preferences**
    - ***Dunn and Dunn*** *model (despite a large and evolving research programme, forceful claims for impact are questionable because of limitations in many of the supporting studies and the lack of independent research).*
    - ***Gregorc*** *Mind Styles Model and Styles Delineator (theoretically and psychometrically flawed. Not suitable for the assessment of individuals).*
- **Learning styles reflecting deep-seated features of the cognitive structure, including patterns of ability**
    - ***Riding*** *Cognitive Styles Analysis (the simplicity and potential value of the model are not well served by an unreliable instrument).*
- **Learning styles as one component of a relatively stable personality type**
    - ***Apter*** *Motivational Style Profile (a theory which poses a threat to fixed trait models of learning style and which merits further research and development in educational contexts).*
    - ***Jackson*** *Learning Style Profiler (the theoretical model and the LSP, for which UK norms exist, have promise for wider use and consequential refinement in organisational and educational contexts).*
    - ***Myers-Briggs*** *Type Indicator (It is still not clear which elements of the 16 personality types on the MBTI are most relevant for education).*
- **Learning styles as 'flexibly-stable learning preferences**
    - ***Allinson & Hayes*** *Cognitive Styles Index (the CSI has the best evidence for reliability and validity of the 13 models. The constructs of analysis and intuition are relevant to decision making and work performance in many contexts, although the pedagogical implications have not been fully explored. Suitable tool for researching and reflecting on teaching and learning.)*

- ***Herrmann*** *Brain Dominance Instrument (a model which, although largely ignored in academic research, offers considerable promise for use in education and training).*
- ***Honey & Mumford*** *Learning Styles Questionnaire (has been widely used in business, but needs to be redesigned in order to overcome weaknesses identified by researchers).*
- ***Kolb*** *Learning Style Inventory (one of the first learning styles based on an explicit theory. Problems about reliability, validity and the learning cycle).*

- **Styles as learning approaches and strategies**
  - ***Entwistle*** *Approaches and Study Skills Inventory for Students (potentially useful instrument for some post-16 contexts outside the success it has had in HE, but significant development and testing needed).*
  - ***Sternberg*** *Thinking Styles Inventory (unnecessary addition to the proliferation of models).*
  - ***Vermunt*** *Inventory of Learning Styles (rich model validated for use in HE contexts with potential for more general use in post-16 education where text-based learning is important. Reflective use of the ILS may help learners and teachers develop productive approaches).*

Within each family the authors carry out a review of the themes and concepts that link the theorists in the group, and then proceed to carry out very systematic evaluation of each of the 13 chosen models, looking closely at the empirical support and pedagogical impact.

Coffield et al conclude: *"In the current state of research-based knowledge about learning styles…there is no consensus about the recommendations for practice".* They go on to state*: "As we have seen, for example, with regard to Dunn & Dunn, Gregorc and Riding, our examination of the reliability and validity of their learning style instruments strongly suggests that they should not be used in education or business. On the other hand, the research of Entwistle and Vermunt, which is both more guarded in its claims and built on more solid theoretical foundations, offers thoughtful advice that might, after careful trials and revisions, be extended to post-16 learning outside HE."*

The report is highly critical of most current practice in the use of learning styles instruments, and also of the empirical underpinning of most of the assumptions made about the importance of learning styles in education. However, the report tries to deal in a balanced way with the observation that the approach is very popular with practitioners. Coffield et al make a positive recommendation for learning styles instruments (at least those that stand up best to research scrutiny: particularly those of Entwistle and Vermunt) to be developed as tools for encouraging reflection on learning, and further self development. The authors recommend that the *language* of the concepts developed by Entwistle and others of *deep, surface and strategic approaches to learning,* and Vermunt's *meaning-directed, application-directed and reproduction-directed styles* should be widely adopted in post-16 education. They raise awareness of learner differences that point to important pedagogical approaches and thus provide a 'lexicon of learning for dialogue'.

The evaluation becomes more positive as we move across the 'fixedness' categories towards a view of learning style that encompasses an individual's strategic flexibility in how they approach study. The approaches of both Entwistle and Vermunt derive from the work of Marton and his co-workers (Marton & Säljö, 1976, 1997) who described the concept of *approach to learning* with its categories of *deep* and *surface*, to which was subsequently added an *approach to studying* which could be *strategic* (Entwistle & Ramsden, 1983) and *achieving* (Biggs, 1987). This can be thought of as having broadened the concept of learning style to include aspects of the teaching-learning environment being provided. Students'

perceptions of the teaching and assessment procedures, rather than the methods themselves, affect directly how individual students approach their tasks(Ramsden, 1997; Entwistle, 1998).

From interviews with teachers came a set of concepts paralleling the work on student learning. Teachers in tertiary education settings differ in both their *conceptions of teaching* and their *approaches to teaching.* Prosser and Trigwell (1999) described teacher individual difference categories that distinguished a *teacher-focus* linked to *information transmission* from a *student–focus* with an emphasis on *conceptual change.*

All this seems very compatible with a constructivist pedagogy where a focus on the conceptual development of the student leads to teaching and assessment methods that emphasise and support the students' understanding, and so encourage a deep approach to studying (Entwistle & Walker, 2002). Recently Entwistle and his colleagues have begun to link their approach to learning styles with an innovative way of thinking about the development of understanding of subject matter itself. Entwistle and Smith (2002) have recently distinguished between *target understanding* and *personal understanding*. Target understanding describes the understanding that teachers and examiners have in mind in setting out the curriculum to be studied, while personal understanding includes the range of understandings actually reached by individual students. They have started to explore the concepts of *troublesome knowledge, threshold concepts,* and *delayed understanding.* They are focusing their research on certain concepts that are not only difficult for students to grasp, but are also serve as 'portals' to a developing understanding of the subject, "opening up a new and previously inaccessible way of thinking about something" (Meyer & Land, 2002). Scheja (2002) found that electronics students experienced what he called 'delayed understanding', where achieving a full grasp of a topic has to be postponed until an appropriate level of understanding has been achieved through further study. It remains to be seen whether this strand of work can achieve a full integration of individual differences with constructivist pedagogy.

5. Pedagogical challenges for learning technology

The Coffield et al report also makes some very interesting points about learner-centred pedagogy in general arising from their analysis of the learning styles field. Three points in particular seem important to consider in the context of implications for technology-based learning: doubts about the validity of matching as a pedagogical principle, doubts about the argument for metacognitive training, and doubts about the benefits of individualised teaching.

5.1. *Matching*

Matching refers to the practice of linking learning styles with teaching styles. It seems a fundamental point that if we have diagnosed a learner as learning in a particular way then our pedagogy should work to provide teaching that matches the individual's preferred approach. This is the fundamental rationale for Snow's ATI approach, as well as the point of most attempts to produce learner models in intelligent tutoring. Coffield et al review a large amount of research evidence on this (although not technology-based matching) and conclude that the evidence is "equivocal at best and deeply contradictory at worst" where controlled attempts have been made to achieve matching. However, these studies have all been based on the idea of matching to a learner's preferences and they do not take account of the point that preferred approach may not be the same as need. Indeed, there are even arguments in favour of deliberate mismatching as a way of stretching learners and encouraging them to develop a range of styles (Grasha, 1984; Vermunt, 1998; Kolb, 1984). This begins to convey a constructivist flavour. Mayes & Fowler (2000) argued that learning is fundamentally unlike any other kind of work, where the goal is normally to achieve task goals in the most direct and efficient way. To achieve deep learning it is sometimes advantageous to set barriers for the learner to overcome. The importance of challenging students' existing ideas or beliefs as a way of provoking development can be found in the classic work of Perry (1970). Säljö (1982) also reported that the conceptions of learning of some of his students were changed by their realisation that the learning that was now required of them differed from what they had used previously.

Recently, Vermetten, Vermunt and Lodewijks (2002) have been investigating the effects of introducing *student-oriented education* in several degree courses in Tilburg University in The Netherlands, comparing the inventory responses of students who had experienced the innovation with students who had not.

Individual differences were indeed found, with students appreciating aspects of the environment which suited their own way of learning. Deep and highly self-regulated learners indicated that they do not need detailed manuals, whereas surface/undirected learners wanted to have them more often.
"This study makes it clear that direct influence of instructional measures does not take place... It seems that students prefer, and act as if there is 'congruence' between the learning environment and their own learning habits. However, (constructive) 'friction' between teaching and learning is often necessary to make students change and to develop their learning strategies" (Vermunt & Verloop, 1999) quoted by Entwistle, 2003.

Coffield et al (2004) also discuss the arguments that it is simply unrealistic to expect matching given the demands it would make for flexibility by teachers and trainers, although they fail to acknowledge that it is precisely the requirement to achieve this flexibility that makes the case for computer-based matching.

5.2. *Increased self-awareness and metacognition*

There are strong arguments in favour of using learning styles instruments to increase the self-awareness of students and tutors about the range of approaches that are possible in learning tasks, and about their own assumptions, and to encourage them to reflect. Apter (2001) gives an additional advantage: that learners will become more in control of their *motivation*. As Entwistle has shown, students often bring to any programme some firmly established study habits, some of which will be inappropriate. These habits may have been formed through some strong guidance about what work to do and when it is required, whereas post-16 education depends increasingly on self regulation. Yet, as Coffield et al imply, simply being given the results of a completed learning styles inventory is unlikely to be helpful without a dialogue with a teacher who has both some knowledge of the individual learner and a more sophisticated understanding of the theoretical basis of learning styles than would be achieved through normal teacher training.

It may now be the time to argue that the ability of technology to track individual learning performance in detail should be exploited in a new approach to individual differences in learning, where both learners and tutors are provided with as much summary tracking data as possible, providing a personal profile of achieving understanding in its full complexity. It would be the *learner's* task to derive meaning about their own learning from this data, rather than have it provided in the form of a theoretically-challenged digest. Such an approach would sit well with a constructivist pedagogy.

5.3. *Individualised teaching*

Perhaps the most surprising pedagogical point made by the Coffield et al report is to query the benefits of individualised teaching. It is hard to accept this. If individualised teaching really has little value then one must ask not only why so much practitioner interest is devoted to the attempt to classify style, but also question the value of much formative assessment which targets feedback to individual learners. Since individual feedback is often regarded as a kind of holy grail of learning technology then the point should be considered very carefully indeed.

Coffield and his colleagues assert the following:
"Our recommendation in favour of increased self-awareness should not, however, be interpreted as support for more individualised instruction, as Kolb (1984) has argued. The benefits of individualised instruction are often greatly exaggerated.."

Coffield et al quote the meta-review of Hattie (1992) who, in surveying 630 studies, found an average effect size of only 0.14 for individualised teaching in schools. They note that the potential of ICT for individualised instruction remains unevaluated, but assert that it is not likely to work if it means more 'unsupported individual learning'. It is not clear what exactly is meant by this term. If it means that the initial instruction might be individually matched to characteristics of the learner but no individual feedback would necessarily follow; if the learner is not required to act in some way to reveal the extent of his or her learning and then to be given feedback on that action, then, whether or not Kolb's approach is valid, this

would simply not conform to the basic requirement of constructivist pedagogy. The essential requirement is that learners engage in personally meaningful tasks and are given personally meaningful feedback.

6. Conclusions

1. This paper has addressed the question of what it might mean to develop a truly learner-centred pedagogy. It has not attempted to tackle that question by including all aspects of a learner's experience that might bear on their approach to learning. That would require a much wider consideration of social and affective factors. The treatment here has been limited to those aspects of learner behaviour that are usually addressed by differential psychology, particularly ability. The paper has attempted to unravel the construct of learning style by adopting Jonassen and Grabowski's framework in which learning style is seen as derived from cognitive style which itself can be regarded as an aspect of ability.

2. Our discussion of the ways in which learning style can, or should, be measured draws heavily on the recent comprehensive evaluation of learning style inventories carried out by Coffield et al. They are in complete agreement with the conclusion arrived at earlier by Curry (1990) that "*…no single learner preference pattern unambiguously indicates a specific instructional design"* .

3. Coffield et al do, however, recommend that the approaches to learning style that lie at the 'flexible' end of their classification of learning styles inventories should be further developed for pedagogical use. In particular, the approaches of Entwistle and Vermunt are evaluated positively. These recognise more strategic and flexible approaches to learning than those that assume an individual learner can be described by a more or less stable profile.

4. The most plausible use for learning styles in post-16 education lies in reflection and in the development of meta-cognitive strategies, where learners are both given insight into their own profiles as learners and are encouraged to consider using alternative strategies.

5. This paper has also considered the question of the matching (which includes deliberate mismatching) of pedagogy to individual aptitude, drawing on the work of Snow, and considering the critique of matching by Coffield et al. The conclusion here must be that the field is not yet sufficiently mature, either in its selection of appropriate individual differences, or in its range of pedagogical techniques, to produce specifications for the role of technology. Nevertheless, it is suggested that there is potential for displaying rich tracking data on an individual learner's performance and using this in a constructivist way to encourage learners to produce their own hypotheses about the effectiveness of their own learning. Such an approach would build directly on learners' own insight into their learning, without a mediating theory being required at all. It also seems promising to build on the recent work of Entwistle and his colleagues in trying to describe differences between learners in terms of their direct interaction with subject matter, ie describing not just a generic pattern of learning but also identifying specific patterns of understanding particular content

Coffield et al point to the strange isolation of the learning styles field in which the research has become inward-looking and disconnected from the main discourse on pedagogy. They point out that in the last 20 years there has been only a single use of the term 'learning styles' in the prestigious Annual Review of Psychology. Yet they also point to the great popularity of the concept amongst practitioners. It would certainly be a mistake not to try to build on this interest which is, after all, an attempt to put into practice a pedagogical idea. However, in the context of the short history of e-learning, in which we have seen a tendency for technological solutions to be produced on the basis of an overly simple pedagogical theory, we are probably right to be cautious.

7. References

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