

An introduction to Multimodal Concept Mapping: approaches and techniques

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ABSTRACT

Mapping provides a holistic multimodal means of sharing the relationship of concepts collaboratively on a single screen or page. This piece aims to provide an introduction for practitioners to the general approaches and techniques using mapping concepts in teaching and learning. Firstly the many definitions of ‘concept’ or ‘mind’ mapping are outlined in the context of teaching and learning. Multimodality refers to the fact that maps, unlike an essay, do not just use words to convey meaning. In this context, the characteristics of hand-drawn maps are contrasted and compared with the features of digital maps. Secondly the theoretical approaches behind mapping are presented from two informal perspectives: thinking and seeing. In the first section, Novak, Cañas, Buzan and Åhlberg are identified as the main exponents of maps as a means of promoting richer and deeper abstract thinking about key concepts in education. However, although the maps as defined by these academics contain visual elements like nodes, links and arrows, the key mode of communication is still words. The pedagogical approach is basically a constructivist one because the learners are being asked to reproduce accurately concepts that they have been taught.

The second section on mapping theorists concentrates on the work of semioticians such as Kress, Van Leeuwen and Mavers who do not privilege words as the key aspect of maps, and even encourage maps without words. Their approach to pedagogy is rooted within the social and cultural context of the student. The original ideas of the map-makers are valued because they represent the world as they see it, rather than replicating what they have been told. In this approach, where the teachers are also the learners, all the modes of communication take equal weight as signs invested with meaning. These modes might include colour, shape and position. Texture might also have meaning if the map is hand-drawn. In addition, Jewitt’s work in multimodal literacy provides further framing in the analysis of dynamic digital maps where multilayering, hyperlinking and the addition of sound and animation files might be significant in the subtleties of meaning they convey.

The third section of this paper focuses on the three common ways in which practitioners analyse the maps; meaning in numbers, meaning in labels, and meaning in signs. Finally, some suggestions are made about the opportunity for innovation in teaching and learning that maps represent in stimulating collaborative thought, identifying higher order concept and in a range of assessment contexts. All the referenced interviews and submissions from the experts were provided exclusively for this piece.

DEFINING MAPPING

Mapping provides a holistic multimodal means of sharing the relationship of concepts collaboratively on a single screen or page. This article provides a brief outline of mapping approaches and techniques for education practitioners who are new to this innovative

teaching and learning tool. The article addresses the beginner in this visual learning field who wants to distinguish between the basic approaches to mapping and to understand the choice of analytical methodologies available to practitioners.

There are three key definitions that are often used interchangeably to describe the mapping process: mind mapping, concept mapping and multimodal mapping. However, each of the terms has a more precise academic definition than this piece will cover. The papers in this volume, on the other hand, authored by practitioners, reference a plethora of other mapping terms that each have a precise definition depending on the angle of approach. A tentative list of the most common terms includes: spider diagrams, knowledge maps, clustering, graphical organizers, consensual maps, spidergrams, scaffolds, mind tools and flowgrams. These will not be covered in this brief outline. For simplicity, throughout this article ‘maps’ and ‘mapping’ are the generic terms used. All the referenced interviews and submissions from the experts were provided exclusively for this article. The first of these contributors is Åhlberg ([extract 1](#), [extract 2](#)), followed by [Novak and Cañas](#), [Buzan](#), [Kress](#) and [Mavers](#).

THEORIES OF MAPPING

Åhlberg a mapping theoretician from Finland, gave an [interview for readers of this volume](#) in which he explains the history of mapping, which began in the third century. However, in this theoretical outline just two current schools of mapping are identified. First the Maps for Thinking school that includes Buzan’s ‘mind maps’, Novak’s ‘concept maps’ and Åhlberg’s extensions of concept mapping construction methodologies. These maps for thinking are developed by learners, individually or in groups, who are interpreting the concepts that have been explained to them by their teachers. This kind of map is particularly useful in developing science and maths concepts. The second school of mapping, called here Maps as Signs, concentrates on the meanings conveyed by the multimodal features of maps. These ‘fascinating cultural objects’ are created by learners who are not constrained by what they have been taught, but are invited to express the original ways in which they see their world (Mavers 2004). Teachers have much to explore about learning and learners from a close and respectful examination of both kinds of maps.

Maps for Thinking

Some theoreticians believe that mapping more closely resembles the way the mind works than writing texts in words. Two key mapping techniques are important in understanding this approach: ‘concept maps’ and ‘mind maps’.

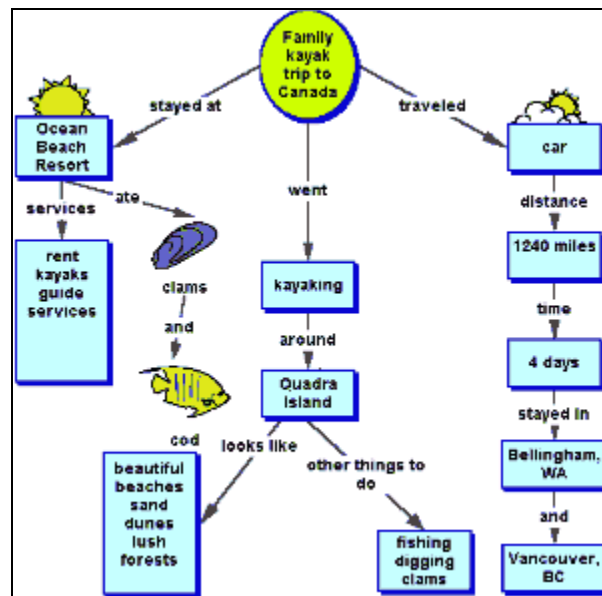


Figure 1: A Novak style concept map

Figure 1 provides a sample of a concept closely associated with Novak who has been publishing in this field since the 1980s (Novak and Godwin 1984). These maps emphasise hierarchies of ideas in a prescribed construction, which aim to pinpoint the most and least important thoughts as well as their relationships to each other. The labelled ovals are called ‘nodes’ and the lines marked with arrows are called ‘links’.

Novak began using maps in the teaching of science concepts at Cornell University in the 1960s. Novak based his mapping approach on Ausubel’s theories about how the mind works in assimilating new concepts and propositions into the existing concept and propositional frameworks held by the learner. Novak used these theories to introduce more constructive or meaningful learning into the classroom at a time when learning by rote was the norm. For Novak meaningful learning requires three conditions: the material to be learned must be conceptually clear and presented with language and examples relatable to the learner’s prior knowledge; the learner must possess relevant prior knowledge; the learner must choose to learn meaningfully (Novak and Cañas 2006; Novak and Cañas 2006).

Recently the digital software designed by Novak and his team has allowed for the easy creation of an electronic portfolio, called a *knowledge model*. The use of the internet and other resources to build electronic portfolios makes possible what Novak calls A New Model for Education which puts the student at the centre of knowledge creation. For teachers who want to pursue these map making methods in more detail, [Novak and Cañas have contributed a paper to this volume](#) dedicated to teachers that explains these processes in greater depth including a detailed account of Ausubel’s learning theories.

Out of these notions about thinking came a necessity to find a better way to represent children's conceptual understanding. The idea of representing children's knowledge in the form of a concept map emerged from this line of argument:

Concept maps, as we define them, are graphical tools for organizing and representing relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts. Concepts and propositions are usually organized hierarchically, from most general, most inclusive to most specific. It is best to construct concept maps with reference to some particular question we seek to answer, which we have called a focus question. The concept map may pertain to some situation or event that we are trying to understand through the organization of knowledge in the form of a concept map, thus providing the context for the concept map (Novak and Cañas 2007).

This is a cognitively demanding form of diagrammatic representation. Novak provides the teacher with clear pedagogical steps that lead up to the development of a concept in detail either as an individual or group task. After devising a carefully formulated *focus question*, the teaching sequence proceeds with a *brainstorm* when related concepts are placed in a 'parking lot' until they are required by the map-makers. The maps go through several iterations illustrating a growing understanding of the relationships between the units of information and higher levels of cognitive activity. In a concept map, two or more concepts are linked by words that describe their relationship. In Novak's view these concept maps encourage understanding by helping students to organise and enhance their knowledge on any topic. They help students learn new information by integrating each new idea into their existing body of knowledge. The maps are ideal for measuring the growth of understanding. Learners reiterate concepts using their own words. Misdirected links or wrong connections can alert teachers to gaps or misunderstandings in their knowledge. In this way, Novak claims, concept mapping provides an accurate, objective way to evaluate particular areas requiring additional explanation to complete students' understanding.

Åhlberg suggests a series of developments to Novak's concept mapping process, which allows the map maker more autonomy in the making of their maps (Åhlberg 2004). In his system, all concepts are interpreted as main elements of thinking and learning, and they are always inside frames. He prefers not to limit how many words may be included in a concept label or the length of a verbal expression. In order to have a meaningful proposition, all links between concepts have arrowheads in his system, to show in which direction the connection from one concept to another is to be read (Åhlberg 1993). Åhlberg has contributed a more detailed article [about these methods of construction](#) for readers of this volume who would like to study this area of mapping in more detail.

Like Novak and Cañas, Åhlberg also advocates the use of digital software which permits map makers to work across a server and comment on the maps of others. In this way students learn to build knowledge not just as individuals but in groups, which Åhlberg sees as an important skill in the emerging global knowledge society.

Buzan offers a different theory from Novak, Cañas and Åhlberg about how the mind thinks. The term ‘mind map’ has been patented by Buzan, who, since the 1970s, has written widely about using maps which radiate from a central node (Buzan 1993; Buzan and Buzan 1993; Buzan 2002). This method is widely used by individuals for note-taking both in commerce and in education Figure 2 provides an example of what these maps look like. Like Novak, Buzan is also quite prescriptive about how these maps should be constructed.

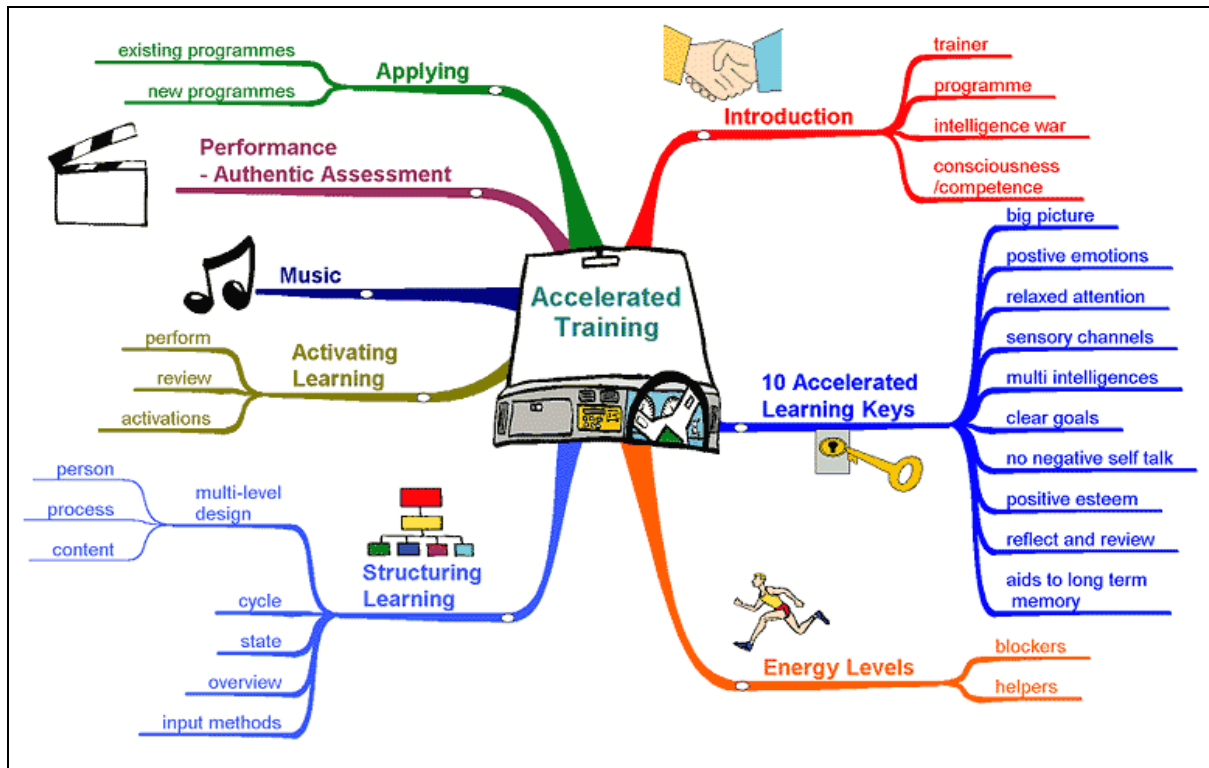


Figure 2: A Buzan style mind map (www.mind-mapping.co.uk)

Buzan contends that the construction of his mind maps are a manifestation of how the mind works. But, of course his maps look entirely different from Novak's. Central to the theory is the notion that the brain is a visual image-based thinking organ rather than language-based. Buzan brings enthusiasm for the role of colour and curving line in his belief that his radiant map design mirrors the way that the mind works. He gave an enthusiastic [interview for readers of this volume](#) in which he argues that images are more important than words in cognition.

We have been under the misapprehension for some many many centuries both from the philosophical perspective and the psychological perspective that mankind thinks with words. What I'm saying is that humankind thinks with images and the radiant associations from those images and that words are very important, but never the less sub routine of thinking.

In the following extract from the podcast he explains how radiant mind maps reflect his belief in how the mind works, a thinking process he calls radiant thinking:

On mind maps the image is always in the centre because that is the focal point, that is the point from which your brain radiates thought. So if a note taking system does have an image in the centre, does use images throughout, does use colour, does have curvilinear line and does have one idea per line, per curvilinear line, then that different thinking technique is a mind map.

Mind maps must Image in the centre, images and key word throughout. Colour, curvilinear line, single key words per line and associated flash network. A mind map is like an internet of your brain

Buzan specialises in books and courses that are designed to increase the effectiveness of company employees and learners in schools. He has also developed speed reading techniques and social intelligence awareness (Buzan 1993; Buzan and Buzan 1993; Buzan 2002). Promoting recall or memory of facts is Buzan's main aim in promoting mind mapping, which is widely used by individuals who want to explore their personal styles of recall and note taking. Åhlberg offers a word of caution by pointing out that one of the few research reports about mind mapping and learning suggests that the process is probably only significantly useful in the field of factual recall rather than higher order thinking (Farrand, Hussain and Hennessy 2002). In the same vein, the term 'mind map' might be overstating the capacities of these maps that cannot actually illustrate the full contents of the map-maker's mind as this term implies. The more accurate term for maps illustrating thinking is more correctly a 'concept map' because this term defines more clearly the finite purpose of these maps: to express concepts within a particular category or class of thought from the learners' point of view.

There is, on the other hand, another way of looking at these maps which puts far more emphasis on what the map maker chooses to do if they are given freedom in how to draw a map. In this approach teachers will be looking for signs of how the learner is thinking spontaneously rather than for how accurately they are reproducing information that has been given. The next section explores all the multimodal elements of the map that have been combined to make meaning by the map-maker.

Maps as Signs

Semiotics means the analysis of signs or the study of the functioning of sign systems. A word is just one kind of sign amongst the many that humans use to convey meaning, for example gesture and tone of voice. In semiotic terms, although Buzan is concentrating on thinking processes, he does pay more attention to the multimodal characteristics of the maps than Novak and Cañas by emphasising, for example, the colour coding and the curvilinear lines that emanate from the centre. Nevertheless, the knowledge stored in mind maps for thinking is still dominated by the words or phrases describing concepts.

Capacity in traditional reading and writing has always been referred to popularly as literacy. Now this kind of literacy is sometimes called monoliteracy to highlight the contrast with multimodal literacy, which is still being defined (Kress, Jewitt et al. 2001; Kress and Van Leeuwen 2001; Jewitt 2002; Jewitt 2003; Jewitt and Kress 2003). The semioticians would consider the word labels on the maps, if there are any, as just another sign in a visual mix

which conveys meanings that stretch beyond words. Kress and Van Leeuwen have made tentative efforts to establish a grammar of visual design by describing a range of ways in which reading images has similarities with reading words (Kress 1996).

In the traditional school setting the materials most easily to hand for the pictorial representation of concepts are often just paper and coloured pens or paints. But in her study of the digital landscape in learning in the 21st century, Jewitt shows how access to digital technologies in classrooms gives learners far more resources for sophisticated meaning making. Within the term, multimodal digital resources, she includes simulations, virtual reality learning environments, electronic books, discussion forum applications, spreadsheets, hyperlinks and hypertext. She also cites the range of representational modes that learners handle in school and at home that make up their multimodal literacy: still image, movement, colour, sound effect, music, speech (voice) and writing (Jewitt 2003). In another publication she includes the photos, graphics, sound, animation, texture and multi-layered diagrams which are undermining the dominance of the written word (Jewitt 2002).

Whereas the 'Maps for Thinking' theoreticians use mapping to extend and enrich thinking processes to make them more explicit, the 'Maps as Signs' researchers see mapping as one aspect of a revolution in the ways in which concepts are now communicated in society. Multimodal literacy relates to the grammar of the visual image, a recognition of the importance of the maps as communicating meanings through graphics, composition, spatial arrangement and links emphasising the interplay of multimodal elements and the visual and spatial metaphors which may be beginning to displace the dominance of words in meaning making (Mavers 2004).

Kress, a leading semiotician, is also inclined to think that the multimodal characteristics of the map have more significance than the words, and, in fact, maps do not need to display words at all. The word 'semiotics' can seem rather esoteric, but, especially for the readers of this volume, Kress explains his belief that the teaching profession have a serious interest in this field even if they do not use the term 'semiotics'.

Kress argues that the link between learning and meaning is very strong. But in the world of semiotics meaning is not just contained in words. Kress talks about meaning in talking, writing, gesturing, smiling and shrugging the shoulders. Meaning, he says, is made by what people wear, by the way they shop and by the kind of car they have. Children carry meanings from the world outside of school into the school. A study of semiotics provides teachers with a tool to understand meanings their students bring in to the classroom.

Kress thinks of maps as holistic images that are designed to express meanings that cannot perhaps be explained by words. He describes an example of what happens when a two year old is asked to tell a story about her trip to the forest. With a pen in her hand, she draws a line that moves in all sorts of directions because she has to go round trees, into a cave, over a mountain and across a stream. In fact she is drawing an early map. It is a representation of the journey. In this example a map is a material realisation of meaning.

Maps, he suggests, support learning because they enshrine or encode the world that the teacher wants the learners to engage with. Maps are a way to draw their attention to the

relevance and salient features of the world and the connections of the elements in it. A map becomes a particular kind of learning environment.

Kress and Leeuwen (1998) draw an affinity between the shapes of maps of associations and the interconnectivity of the internet. In this context, Kress suggests that the opportunity to draw a map freely might be particularly relevant to young people. This is because the world is becoming increasingly interested in making lateral connection and network horizontal links rather than prescriptive tree structures associated with hierarchical and vertical lines. He thinks it is possible that this general trend or tendency towards maps that look like networks is spilling over into other kinds of visual representation.

Kress also thinks that maps represent a new form of thinking. In old forms of thinking expressed in hierarchical organisations, the authority in power tells the learner what they must learn. Power in a contemporary organisation is more horizontal. Everyone can organise the environment around them according to their own interests. He also thinks that new forms of assessment should be organised in a similar way tending to people's interests, rather than exercising power over learners by insisting on what they must learn. In traditional thinking meaning relies on language. As a result forms of assessment are tied down with language. Maps, he suggests, might provide an alternative way for teachers to assess meanings that are beyond words and move closer to the processes of communication.

The notion of multimodal literacy that has been developed in recent years also helps to illuminate the potential of maps in teaching, learning and assessment. The basic assumption of multimodal literacy is that meanings are made, distributed, received, interpreted and remade in interpretation, through many representational and communicative modes – not just through language – whether as speech or as writing (Jewitt and Kress 2003). The multimodal concept mapping under discussion in this paper represents just one manifestation of this multimodal literacy, which is emerging in schools, homes, industry and commerce in the twenty first century. The term multimodal mapping (MMM) has been adopted in this paper as an umbrella term used for any manifestation of mapping ideas, hand-drawn or digital, which have been developed in the area of learning to communicate meaning visually. The term 'multimodal mapping', which references the work in multimodality of Jewitt, Kress, van Leeuwen and Mavers, is employed to avoid being identified directly with any of the more prescriptive mapping approaches that exist in concept and mind mapping. The term is intended to emphasise the participants' freedom to interpret the drawing of maps in any way they prefer. This approach to mapping is best exemplified by the large scale project undertaken by the ImpaCT2 research team (Mavers, Somekh et al. 2002).

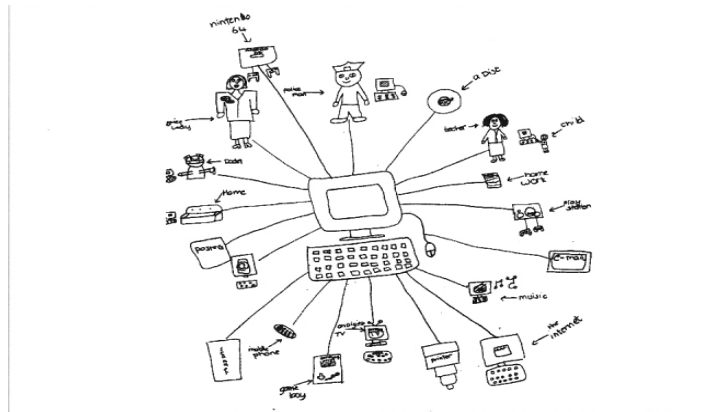


Figure 3: a child’s multimodal map from the ImpaCT2 study in ‘radiant style’

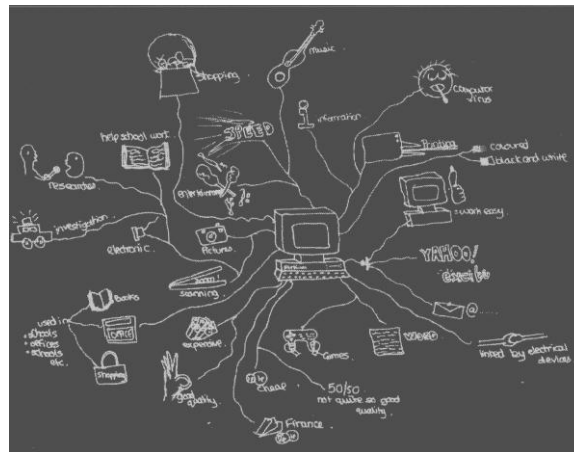


Figure 4: a multimodal map from the ImpaCT2 study in ‘radiant style’ showing a series of sub-branches

These two maps in Figures 3 and 4 are evidence of the detailed and complex semiotic representations of networked technologies that young learners achieved in twenty minutes. Although these two maps present radiant approaches to the mapping task of presenting of 'Computers in my World', the 2000 young people in the study of 10-15 year olds created a range of different shapes in hand-drawing their concepts: one-centred, several centred and a spaghetti approach with no clear centre. The group of map-makers showed sophisticated understandings of digital networks which had been built up largely outside the school. The value of the maps in learning is demonstrated by the level of complexity of ordered conceptual representation achieved by these secondary school pupils in twenty minutes. It is unlikely that an essay title, *Computers in my World*, would have elicited the same kind of detail.

What is impressive about this paper is the researchers' respectful attitude towards the maps as 'fascinating cultural objects full of unique detail and often aesthetically pleasing'

(Mavers et al. 2002 p.191). This comment illustrates the attitudes of these semioticians, who are interested in defining what the pupils already know instead of assessing their replication of what they have been told. This attitude towards learning challenges the conventional ways in which students are assessed and what topics are assessed and how (Jewitt and Kress 2003). The paper recommends that there should be significant rethinking about how computers are taught in schools and in the profession's attitudes towards technologies that students bring in to school.

In this context, practitioners need new analytical methodologies to interpret the meaning of these multimodal maps alongside a new understanding of who assessment of maps might benefit. Some basic analysis techniques are covered in the following section, which will be useful to teachers who are developing projects as work based researchers.

METHODS OF ANALYSING MAPS

The purpose of the maps

The papers in this volume indicate a range of ways in which practitioners might want to use mapping to enrich learning, empower learners, increase productive talking, raise achievement and develop understanding of the influence of social and cultural factors in the learning context. For example, Clarke, Riley, Rojas-Drummond and Anzures Tapia, and Ralston and Cook all also make reference to the value of the maps in stimulating purposeful and constructive talk. In their studies they refer to the collaborative making of digital maps and to the discussion about them by groups looking at visual displays. These practitioners have based their studies on the classroom observations of Mercer, Dawes and Wegerif that concentrate on developing thinking strategies linked to purposeful talk (Mercer 2003; Wegerif and L. 2004; Mercer, Littleton et al. 2004).

In a work-based learning or practitioner research context the practitioner can use the maps as a data collection tool to increase understanding of learning processes. The students can also be involved as researchers into their own learning processes which adds a self assessment dimension to the project. Used in self-assessment and group assessment, maps can improve learners' understanding of their personal learning styles and help them to develop, compare and share more effective strategies for learning achievement. This is not an exhaustive list of an approach where there is still much to learn.

Setting the question

Practitioners will prepare for a mapping exercise by making sure that the initial heading or the question stimulus crystallises the learning challenge. If any comparison of maps is anticipated, the map-makers will also need to be subjected to the same conditions in producing the maps and the same time limitations. The Impact2 team also presented some different map patterns so that all the pupils understood what they meant by a concept map or a mind map. The researchers also made the instructions user-friendly and encouraging, asking pupils to be as inventive and creative with their maps as possible and to use pictures, symbols and labels as appropriate. The team stressed that there were no right or wrong

answers so that the pupils felt confident in offering their own ideas on Computers in my World.

Analysing the maps

Three basic techniques are proposed here for analysing the maps, although several variations are offered in this volume. These are: Meaning in Numbers, Meaning in Words and Meanings in Signs. Practitioners may also want to devise new techniques that meet their particular circumstances as teacher-researchers.

The first technique under the heading, Meaning in Numbers, is about the counting of the nodes and links. This method of analysing maps is exemplified by the practices described in great detail in *Interpreting the externalised images of pupils' conceptions of ICT: methods for the analysis of concept maps* (Mavers, Somekh et al. 2002). The team wanted a method that would elicit patterns across a large number of maps, rather than dealing with them solely as indicators of the thinking of individual pupils. The authors acknowledge that their method was refined from the REPRESENTATION project that had involved a large sample of pupils from six European countries (Crawford, Neve et al. 1999). In essence, after the nodes and links have been counted, a simple connectivity score is derived by dividing the number of links by the number of nodes. This gives a ratio score of 2:1 for simple maps and up to 4:1 or 5:1 for complex spaghetti type maps. If there is more than one scorer, the nature of nodes and links will need to be discussed. The Impact2 team added other measures like the identification of the Spheres of Thinking the pupils were engaged in and the Zones of Use that helped to identify where the pupils' technical competence was sited. These measures worked well in the raw comparison of 2000 learners' responses. However, Mavericks has indicated that this was not always an accurate score in comparing individual learners since these maps are unique constructs (Mavers 2004). The ImpaCT2 team also indicate that this statistical approach does not necessarily preclude qualitative, holistic analysis of individual maps in interview.

The second technique, called Meaning in Words, refers both to techniques for content analysis as well as the structured and unstructured interviews with map-makers to understand the meanings in the drawings. The Impact2 team asked the younger children only to use pictures, but thought older pupils might find this too restrictive at 14 and 15 years. Other teachers and learners engaged in this process of mapping concepts might also find a concentration on pictures instead of words too simplistic for sophisticated concepts or too difficult because they do not feel skilled in drawing. It might even feel threatening as many learners and teachers are not confident in using their own pictures to convey meaning. Researchers would need to be sympathetic to these anxieties. However, the drawback to putting words at the centre of the analysis rather than pictures is that this privileges writing over visual communication. The learners are not being challenged to convey meaning in new ways.

In terms of words a simple way of analysing a class response to the teaching of new concepts is by putting the key concept words that reoccur in a spreadsheet and recording their frequency after the lesson. Riley, in this edition, extended this concept by relating the words used to Bloom's taxonomy of higher order thinking in order to estimate at what level

pupils seemed to be operating (Riley 2005; Officeport 2006). Since words are still one of the main ways in which map makers express concepts, there is some merit in this methodology.

A different way in which words can be used to unpick the concepts in a picture map with complex shape relationships is in a face-to-face interview. This was the way in which the research team in Impact2 discovered a rich seam of meaning in the maps. What was distinctive about the use of interviews is that the children were invited to talk about their maps in their own way instead of being asked structured questions. The researcher made it clear that silences were acceptable. Once she had gained the students' trust, they used the silence for thinking instead of rushing to give 'right answers' in one word as they had been trained. Some students, after some initial hesitation, were able to sustain enthusiastically explanations that lasted up to four minutes. These conversations were recorded and transcribed so that the themes could be extrapolated.

This holistic approach to understanding the maps is further developed in the third methodology, *Meaning in Signs*. This semiotic method is pieced together from a number of studies, which include mention of mapping analysis to pinpoint individual learning. Kress who is one of the leading exponents of multimodal literacy as it emerges provides a description of semiotics for teachers in particular. To teachers who are interested in learning and who believe that learning creates an increase in ways of making meaning or the understanding of meaning, he would explain semiotics as the discipline that deals with meaning. Humans make meaning in many ways. The list of signs that includes talking and writing also embraces gesturing, smiling and the shrugging of shoulders. People, says Kress, make meaning by what they wear, by the way they shop and by the kind of car they have. In his view it is essential to have a discipline or an area of study, which deals with all of these meanings, but in relation to meanings, as they occur in classrooms and relate to curricula as well as meanings that children carry in from the world outside of school. So essentially semiotics is a tool for teachers to understand the kinds of meanings that they deal with and, maybe, those that their students bring into the classroom. This is a summary of one of the points that [Kress made in a podcast about semiotics for the readers of this volume](#) in which he develops the detail of the relationship between semiotics and classroom practice.

Semiotic analysis concentrates on the composition or the design of the relationships, the use of arrows to construct conceptual relationships, and the visual and written narratives. The aim of the analysis is to find evidence of different understandings of how ICT concepts can be represented and the ways in which the concepts relate to a knowledge structures. This analysis provides the researcher with evidence both of what was learnt and what motivated this learning. Clearly, a different approach from testing whether what has been taught has been absorbed correctly.

Kress and van Leeuwen widen the multimodal scope for communicating concepts graphically by looking at other examples of how the global society is using this form of communication, rather than imposing a prescriptive strategy like Novak and Buzan. They select, from contemporary magazines, newspapers and textbooks a variety of linear flow-charts influenced by the notion of networks. These networks offer a freer mode for the

formation of ideas into associations or concepts that are not so dependent on hierarchical structures. They point out that mapping is particularly appropriate for interpreting the internet itself where information is often freely available for those who have perfected their searching techniques. Kress and van Leeuwen also make an important distinction between hierarchical diagrams, which they see as classificational, and networks, which they suggest, are more analytical. These references to networks also allude to the influence of computer networks in new structures for communicating new concepts (Kress 1996). These considerations suggested that the choice of multimodal mapping in the methodology is ideal for representing ICT concepts. The recent advances in digital mapping have increased this similarity.

The following framework for analysis has been adapted from the relevant items in the list of topics covered in the tentative visual grammar Kress and van Leeuwen develop in *Reading Images: the Grammar of Visual* that concept maps shapes were beginning to resemble the networks and hyperlinks of the internet. In this framework, which has been developed here, practitioners can search the maps for signs of:

- narrative representations which relate to designs for social action;
- conceptual representations which relate to the design of social constructs;
- representations and interactions that illustrate design decisions about the position of the viewer;
- modalities illustrating different approaches to reality;
- the meaning of the compositional elements and their interrelations;
- the materiality of meaning: surface textures and inscriptions;
- dimensionality which can be found in multilayering and hyperlinking; and
- meaning in colour.

Mavers investigates the analysis of maps specifically and as a result is able to provide depth about this mode of communication. The careful and respectful examination of children's graphic representations undertaken by Mavericks seeks to identify the variety of ways in which meanings are made on the page and on the screen (Mavers, 2007; Mavericks, 2004). Her detailed observations about children's practices provide exciting insights into their mastery of contemporary text-making. She investigates texts made at school and autonomously at home, as drawing, as writing, and as multimodal combinations of writing and image. These extend to activities such as colouring, gluing and copying which are not normally given this much attention in schools or at home. Of significance in this approach is the respect for the artefacts produced by the children. Mavericks looks in great detail at what has been represented in order to see what can be learnt about young people's meaning-making. In many ways what emerges is that they are not given credit for their sophistication of their text-making. Her study draws attention to the complexities of representation and communication, and how children readily adapt the ways in which they make texts in response to the particular social context. Their representations are subtly different in ways that indicate creative interpretation.

Mavers attends to all aspects of children's meaning-making with seriousness. The evidence indicates that writing and drawing are used by Mavericks' subjects in complex and interrelated ways that tend to be overlooked in schools. Generally, drawing is seen as secondary in

importance to writing. Mavers, on the other hand, argues that drawing is an apt mode to enable certain expressions of meaning. She examines presentational features such as colour, size, accentuation, orientation; the resources of medium such as wax crayons as against the computer; layout, including spacing and punctuation; and deletions as evidence of the ways in which some decisions have been rejected in the design process (something that cannot be traced so easily in the digital medium).

Mapping is one of the multimodal genres that contributes to Mavers' understanding of how children use the resources to hand to make meaning (Mavers, 2003; Mavers, Somekh and Restorick, 2002). The maps Mavers analyses are hand-drawn with a particular emphasis on pictures representing ideas about computers, computer networks and online environments. Her work is particularly important in the study of multimodal mapping because she examines the individual modes of drawing, writing, layout and linkage separately as well as how they are combined as multimodal ensembles. Mavers provides a robust analysis of the differences between the meanings conveyed by word labels and pictures that can be used together to communicate concepts to an unknown audience. Comparing different representations of the internet by pupils, she shows how neither the writing nor the drawing can function without each other. They take on related but complimentary functions that she calls 'co-fixing' (Mavers, 2004: 165).

A key example that has relevance to digital maps is Mavers' exploration of how a young girl uses the resources of a virtual learning environment to make her own web page. What emerges from this analysis is the value of banks of resources that permit the young meaning maker to experiment with different images and fonts as well as their size and position. The medium of the computer provides three new opportunities for entry into the world of the professional designer. Text manipulation through adjustment of, for example, colour and font heighten the meanings of the words. Animated images and animated word-art are not available on the page. For example, a gothic design might denote fear whereas an art deco derivative might denote the twenties, or even jazz, depending on the context. Until recently advertisers and publishers have been able to suggest a particular period, an emotion or a value by using word art, but it has not been available for the consumer to experiment with in standard computer applications. A third feature that was used consummately by the young learner was the opportunity to programme moving text. Whereas print and inscribed writing are fixed, the screen provides the opportunity to incorporate images that are given particular meaning by their movement and to create writing that is not restricted to one form or place (Mavers, 2004: 171). This seems to have been a means of holding the visitors' attention and sustaining that attention over time. In an emergent analysis Mavers seeks to answer some challenging questions about how writing and image now work together in the digital age and what implications this has for text-making and text-reading'.

In particular, what might be important for teachers using maps to engage learners is Mavers' reference to the focus groups' opinions: 'moving text and image are linked with fun, humour, motivation and engagement (ibid)'. The paper from Ralston and Cook in this volume also makes some of these points by drawing on the discussions of the digital mapping as collaborators explored how their use of semiotic resources reveals how they are thinking about concepts. What may be surprising to teachers is the way in which current communication systems are observed, understood and replicated by young learners. What is

also exciting is the new approaches developed by the children themselves as they seek to make meaning.

Mavers' insights into understanding children's learning offer new perspectives for researchers on interview techniques. For the readers of this volume Mavericks has provided an [article that explains these techniques in more depth](#).

Mavers' work does not offer specific means of analysing collaborative multimodal design. Kress and van Leeuwen, on the other hand, offer a perspective on the social semiotic theory behind multimodal learning, which is relevant to the community aspect of learning. This requires analysing the maps from a broader standpoint on the evidence of the discourses presented as a group by investigating the design decisions that have been made, the way in which the map has been produced and what decisions have been made about distribution (Kress and van Leeuwen 2001).

CONCLUSIONS

Practitioners have already begun to explore these implications and developed a wide range of uses for maps in the classroom context. Riley (2007) has begun a summary of the uses of maps which includes:

- generating writing by scaffolding ideas: ideas can be represented through strong visual images and can contain pictures and graphics;
- publishing and display: visual and text representations provide a stimulating form of presentation;
- generating creativity: to identify 'conceptual spaces' and stimulate 'possibility' thinking;
- stimulating discussion and dialogical learning: to promote speaking and listening skills;
- promoting collaborative learning: mapping can be used to generate group work in discussion activities or map production activities;
- directing thinking: as a teaching presentation tool, to organise topic coverage and group activities;
- facilitating higher order thinking: generating thinking skills through finding relationships and identifying gaps in understanding; and
- improving the value of assessment : mapping can provide evidence for formative assessment in assessment for learning activities, as a self-evaluation tool in personalised learning, for teachers to work with students to understand what they already know about a topic and for students using their maps as scaffolds in mentoring discussions in pairs and in groups.

This list, which is not exhaustive, provides a starting point for practitioners who want to experiment. Practitioners can experiment with these ideas to explore the boundaries of learning. For example, collaborative maps can be used in group assessment at the beginning and end of a learning episode. Maps can also be used to record learning progress in single

screen in blogs and e-portfolios. The opportunities, currently, can be explored with imagination and creativity.

However, the role of mapping as a way of challenging traditional thinking may be greatest in the field of assessment. This process can be employed to emphasis the role of participants in terms of setting their own learning agenda. In this way the learners can be encouraged to see the mapping exercise both as a personal ladder to learning and as a means for constructive and socially interactive learning.

In a study of children's maps illustrating scientific concepts, Kress, Jewitt et al. (2001) point out that the need to understand these visual representations is becoming more and more pressing:

Unless we know how to read these texts as full evidence of learning, there is no point in even contemplating [other] forms of assessment (p118)

Digital mapping software now offers sophisticated features in multilayered diagrams which encourage learners to express their concepts by creating multimodal artefacts and by refashioning existing artefacts to attach to their maps. Web-enabled maps offer an even greater range of possibilities. The implications for the profession in interpreting, storing and assessing these maps are substantial. Dissemination and publishing decisions about learning artifacts are a new dimension of learning which have not been offered to learners until the omnipresence of the internet. It also creates a new situation in which the internet audience may judge the success of a map by diverse criteria, which bear no relationship to the judgements a teacher might make. Under these new conditions for learning, maps appear to offer a tool which might be important in rethinking ways of teaching and learning.

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