'The universality and ubiquity of concept maps'[1]

In this section, I explore concept maps from the vantage point of two strands of semiotics that I discuss in detail below: representation and multimodality. This division helps to identify two types of educators: those who mostly think about concept maps as a means of presenting existing knowledge and ideas in a visual way; and those educators who are more interested in how the map maker has presented new and original connections in creative ensembles. This second position indicates an interest in what the map makers know already rather than what has been retained of has been taught. Of course, some educators, like the ImpaCT2 team, see the maps from both perspectives: representational and multimodal.

The focus in the discussion is mainly on how the concept maps are used as research tools and, therefore, comments are made on how various theories relate to the methodological position taken by the ImpaCT2 team. During the discussion I also comment on how the use of the maps in the literature relates to the four different pedagogical perspectives identified in section one: information transmission; constructivism; and social interaction.

What also emerges is how the academic definitions play out in various contexts. The key terms are 'concept maps', 'mind maps' and 'multimodal maps' and their relationship with 'multidimensional concept maps' that are defined as complex multimodal signs in terms of makers, production, levels and modes. Overall the literature study moves from positivist approaches to concept map analysis that stem from a representational viewpoint towards qualitative strategies that are more considerate of the map makers' perspective. The latter tends to be the stance of those interested in multimodality, meaning making and qualifiable multimodal meaning-making. Thirdly the review analyses the literature that covers concept maps as complex multimodal signs. In this section the multimodal affordances of concept mapping software are discussed. Finally the chapter turns to the multiple relationships that are facilitated when concept maps are used between the educator, the researcher and the map maker.

Two semiotic branches: representation and multimodality

The build up to the publication of the ImpaCT2 paper in 2002 first drew my attention to the potential of concept mapping in education (ImpaCT2 is described in Chapter One). However, concept maps have a long history in teaching and learning reaching back to the third century. The focus in this second section of the literature review is to explore concept maps from the

[1] The title of the Canas and Novak keynote at the Fourth international concept mapping conference in Chile 2010 www.itmc.us

perspective of semiotics, first defined as the science of the life of signs in society (Saussure 1916; translated 1974). Semiotics is now established as an all-encompassing term for the study of any sign that is used in a society or culture to communicate meaning. Signs can be realised in many different modes including sound, animation, graphics, gaze and gesture.

Signs are often, therefore, described as multimodal and the capacity to read these signs as multimodal literacy (Jewitt and Kress, 2003). Kress and Pachler (2007) argued that the close connections between meaning making and understanding can be described in semiotic terms as the connection between the making of signs and the making of concepts. In this section concept are explained in terms of two branches of semiotic theory: representation and multimodality.

Concept maps as representational signs

Representation is a theory about the signs that stand in for and take the place of something else. It is through representation that people know and understand the world and reality through the act of naming it. Signs are manipulated in order to make sense of the world (Mitchell, 1995).

Concept mapping has a long history in terms of representation. Aristotle, for example, a Greek philosopher from the third century, considered that man was distinguished from animals by his ability to create and manipulate signs. Aristotle's capacity to use logic to sort human beings into categories is represented in the first branches of this topological map, The Tree of Porphyry (Figure 2.1). The tree is named after the third century Greek Porphyry, who wrote an introduction to Aristotle's Categories. Until the late 19th century, this was still being taught to students of logic (Ålhberg, 2007).

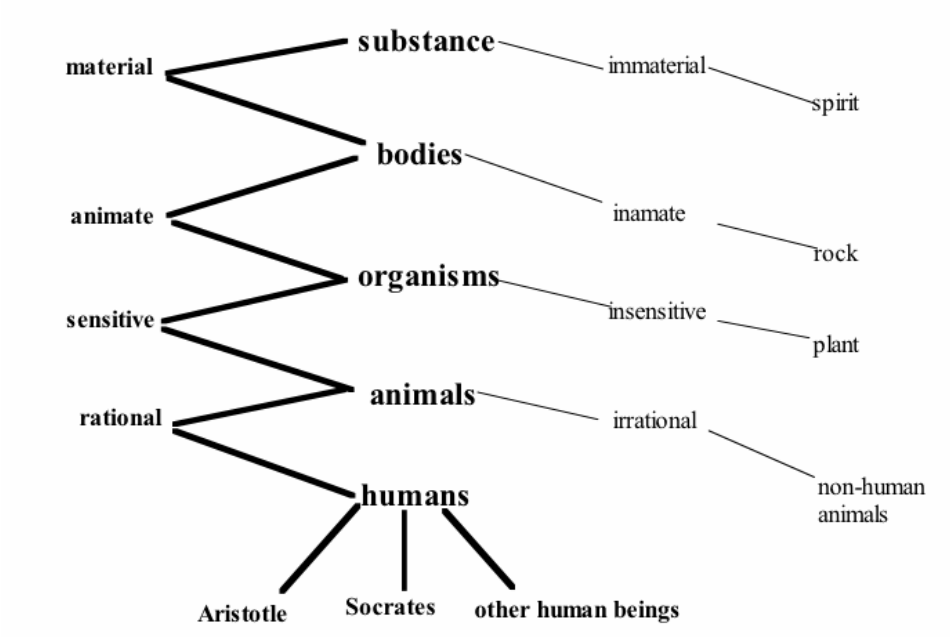

Figure 2.1. The Tree of Porphyry Third century

Common twenty-first century terms for concept mapping used in meaning making as representation include: spider diagrams, knowledge maps, clustering, graphical organisers, consensual maps, spider grams, scaffolds, mind tools and flow diagrams. In the ImpaCT2 study they plan the analysis of the maps on the shapes of maps they had already identified in a European Union study between schools in six countries called Project REPRESENTATION: this name came from the underlying semiotic theories of representation. A variety of map shapes were identified in terms of organizational types: unconnected, (consisting of objects with no links); linear, (where the nodes are linked to only two other nodes in a sequential fashion like the stops on an underground map); one-centred, (with a clearly discernible central node from which links to other nodes radiate outward); several-centred, (two or more nodes acting as centres of interest); and spaghetti (highly complex and multi-lined) (Pearson & Somekh, 2000).

The shadow of Novak

Novak who began his studies in the 1970s is the best known of the concept mappers in education with a very prescriptive approach of the shape of a map should look. Figure 2.1. shows the hierarchical shape he favours – sometimes called a tree arrangement.

Novak is now a distinguished octogenarian who has built a research team at the Institute for Human and Machine Cognition (IHMC) in Florida. He acknowledges that his concept maps differ from other types of mapping systems, such as knowledge maps, conceptual graphs, and mind maps because of: their grounding in Ausubel's Assimilation theory of learning; their semantic and syntactical (structural) organisation, the nature of concepts that comprise the nodes in a Concept Map, and the unconstrained nature of linking phrases. A standard

procedure for Concept Map construction involves defining the topic or focus question, identifying and listing the most important or 'general' concepts that are associated with that topic, ordering the concepts from top to bottom in the mapping field, and adding and labeling linking phrases. Once the preliminary Concept Map has been built, cross-links are identified and added, and review of the map for completeness and correctness is performed (Cañas et al., 2003).

Figure 2.2. A Novakian concept map about concept maps

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 Godwin, 1984; Novak and Musonda,1991; Novak and Cañas, 2006a; Novak and Cañas, 2006b). Novak's early instructions for teachers prescribed exactly the way in which they should teach so that the maps were constructed precisely according to his method. Daley et al. (2010) who draw a literature review of the 300 papers at the 2008 Third Biannual Concept Mapping Conference (CMC) conference in Estonia and Finland[2], group preface their report by quoting Novak (2004) on his first study at Cornell University: 'our ideas developed into the invention of a tool we now call the concept map' (p. 460)'. Novak did

[2] http://cmc.ihmc.us/cmc2008/cmc2008Program.html last viewed September 2010

not, in fact, invent the concept map, as we have seen from the history, - but the influence of his particular approach to mapping has been immense.

The most relevant case study to consider from the point of view of this thesis is the very first use that Novak made of concept maps - as a research tool. The concept map was developed by Novak's research group at Cornell University in the early 1970s as a response to the necessity to find a better way to represent children's conceptual understandings and to be able to observe explicit changes in the concept and propositional structures that construct those understandings, as part of a 12-year longitudinal study following a 2-year instructional period using audio-tutorial instruction in grades one and two (Novak, 1972). This research program was based on Ausubel's (1963; 1968) assimilation theory of cognitive learning and an emerging constructivist epistemology that viewed knowledge as a human creation involving the construction on new concepts and propositions through the process of high levels of meaningful learning, as described by Ausubel, and Novak's human constructivist epistemology (Novak, 1993, 1998). What is notable about Ausubel and Novak when they began to ask students to create concept maps in classrooms is that they were focused on a desire to understand learners' thinking. They promoted constructive learning rather than information transmission, and encouraged the pupils to interact socially to construct the map.

Novak (2002 and 2004) was also influenced by the translations of the work of Russian theorist, Vygotsky, a towering figure in sociocultural educational theory, who has had a profound influence on pedagogy in classrooms. In Russia his varied publications span from 1925 to 1935 when he died. But his influence grew in the West from the 1970s when his work was translated into other languages. Discussing the Zone of Proximal Learning, one of his best known metaphors for learning, Vygotsky argued that, rather than examining what a student knows to determine intelligence, it is better to examine their ability to solve problems independently and their ability to solve problems with the assistance of an adult (1995). Like Vygotsky, Novak saw concept mapping as a constructive means of solving a problem in groups. In addition, he sees language as the basis of cognitive development and social relationships as a vital element in forming concepts.

These were ground breaking perspectives on learning in the 1970s. What is particularly significant for this study, however, is that these first concept maps used in education were not made by the pupils, but developed as research tools to help the researchers. Novak and Cañas explains how concept maps were tested as a means of understanding pupils learning patterns when interviews were not providing the answers:

> While we found structured interviews to be useful in capturing children's understanding, it was difficult to discern specific changes in the children's concept and propositional ideas as they progressed through schooling. Working with a talented group of graduate students, Novak and his colleagues came up with the idea of transforming interview transcripts into a hierarchically arranged set of concepts and propositions representing the knowledge expressed in the interview. Mapping a child's interview transcript often revealed ambiguities not seen previously that required more careful listening to the interview tape to discern additional cues for the child's thinking. Thus was born the concept map tool for representing human knowledge(p.1. Novak and Cañas 2010).

In the next section, I now consider how Novak analyses the maps through the value of the words on the labels and how he scores his maps concentrating on a numerical approach to the links and nodes.

Analysing representational maps

In this section I have covered some of the literature from researchers and educators who see concept maps as representational signs. Those interested in maps in terms of representation tend to see the maps from the semiotic perspective of numbers and words. Numbers, the first semiotic perspective, provide information about map features like the numbers of nodes or links or the frequency that particular words appear. Early Novakian procedures provide quantitative information through scores.

Scoring Novak's maps

Novak claimed that if his system was undertaken exactly according to the procedure, then concept maps would provide an accurate, objective way to assess students' understanding of concepts they have been taught. This is why he had the confidence to devise such a detailed scoring system. This system has been added and modified by his followers depending on the nature of the task as the ImpaCT2 team did in 2002. In 2010, after many more development of scoring systems the Daley et al. literature review records the challenges in applying consistent and reliable scoring methods to the various concept mapping tasks, highlights the variability in types of information about the learner gained using different types of concept mapping tasks, and emphasizes the need to align the content and processes measured by both concept maps and alternate assessments, in order to making inferences about concept maps as valid, reliable measures of science learning. They concluded that reliability and validity are still important issues for considering the use of concept maps as assessment tools. In their view, these problems are exacerbated in 2010 by the presence of different concept mapping formats/techniques, different forms of traditional testing methods and a plethora of concept map scoring systems that add complexity to the act of linking student concept map scores to meaningful learning outcomes.

Meanwhile Novak himself has also moved beyond the emphasis on strict rules and prescriptive scoring still pursued by some of his followers who emphasis the scoring aspects of mapping. In contrast, Novak and Cañas use the internet to build electronic portfolios. Their paper, *A New Model for Education*, put the student at the centre of knowledge creation (Cañas and Novak, 2007). In this model they moved away from information transmission aspects of concept mapping towards 'constructivist' and 'social interaction' perspectives on learning (Bowen and Meyer, 2008).

There is a danger that the ways in which Novak is being translated in classroom contexts can become too prescriptive and formulaic- a mere repetition of what has been taught in a new form. Nevertheless, there are clearly merits in this system which suits well to teaching facts about science, maths and language structures. For example, Riley, a classroom practitioner, has authored papers that explore the meaning of words children use in Novakian maps to develop understanding of language structure (Riley 2005; Riley 2007). His class was well trained in Novak's hierarchical concept mapping system, but Riley avoided the dangers of mere information transmission and reproduction in two ways. He ensured that the young learners have an explicit understanding of the scoring systems and he involved them in the research and reflection process as co-researchers. In this way the maps became useful tools for learning for the map makers as well as the researchers. In fact, the children became action researchers working in partnership with their teachers. This point is returned to at the end of this chapter in the section: multiple researcher perspectives.

Novakian strategies for using words

A key component of the Novak map is the use of language to label the nodes and sometimes, the links. He also prescribed the use of language by the teacher. The sequence of teaching tasks that he advised, move from a teacher's carefully formulated focus question, to a brainstorm when related concepts are placed in a 'parking lot' as words or phrases until they are required by the map makers. The links between two or more concepts are labelled by words that describe their relationship. Because Novakian maps are language-based the level of prescription has become a problem as concept mapping is adopted internationally. For example, some of the detailed scoring prescriptions that rely on English grammar cannot be used in languages with different structures (Khameson, 2008).

Some stronger arguments emerge against Novak's level of prescription in describing how concept maps are to be scored when Mahn and Aguilar-Tamay (2010) collaborate to compare Novak approach to learning with Vygotskian theory. As Mahn and Aguilar-Tamay agree that Novak was influenced by Vygotsky's work on the social value of learning, but as they worked together they realized that the application of Vygotskian theory could expand Novak's work on cognition. Their critique is that Novak and Ausubel believed that the relationship between

word and concept as primary. Novak believed that the concept has been understood when the map maker labels a node: there is no more work to be done. Mahn and Aguilar-Tamay (2010) argued that Vygotsky (1986) may have had a more plausible theory about learning: that the naming of a concept leads to a deepening understanding and further efforts at representation over time. They are now developing research projects to look into the similarities and differences between the Novak and Ausubel approach to language and that of Vygotsky in order to see what can be learnt about the origins, nature and growth of concepts through maps.

The ImpaCT2 score sheet (Figure 1.3) indicates an intention, like Novak, both to count relevant words and to consider if the concept is correct - but these score sheets were intended to collect together the evidence of knowledge about computer networks from 2,000 pupils. Only in the interviews was it possible to gain any qualitative perspective on what each individual map maker had had to say.

The socially interactive aspect of the words on the maps is also important. In some of the case studies the map makers were particularly conscious of their audience. Halliday (1978), probably the most relevant linguistic theorist in terms of mapping, believed that a semantic system is shaped by the social functions of the utterance or verbal sign as a representation, an interaction and as a message to an audience. Each of these three social functions is called a metafunction. The three metafunctions identify: potential meaning; what can be meant; and, what can be done. Explained in terms of mapping, the first metafunction, the ideational meaning, refers to the subject matter of the map; the interpersonal meaning refers to the imagined audience the map maker envisages during the process of production; and, the textual meaning is map maker's awareness of the map as a communication with an actual audience. Halliday was only looking at language as a means of communication whereas Mavers, the concept map researcher from ImpaCT2 explained from this metafunctional point of view the maps have a threefold role as a multimodal ensemble: as a product; as a process; and as a multimodal sign to convey meaning to an audience (Mavers' personal communication, June 2008). This is when words have a socially interactive function in 'learning with others in mind'. The phrase 'Learning with others in mind' is in the title of a paper by Daly and Pachler (2007) that examines verbal exchanges between educators taking a practice based Masters' course who are encouraged to share knowledge online as a 'community of practice.' Their formula for analysing the depth of online exchanges between educators is discussed in Chapter three: the research environment and design.

The third analytical strategy, discussed, in the next section is the map as a complex multimodal signs. In this context, the third sign is described as 'multimodal' to differentiate the meaning because numbers and words are also semiotic signs. I argue that those who see

the maps primarily through a multimodal lens think differently about the value of a map in learning from those who see maps as a representational tool.

Concept maps as complex multimodal signs

The third semiotic perspective is the concept map as a complex multimodal sign. Researchers in this literature suggest that in contrast to a written essay, concept maps are particularly suited to expressing understanding of digital technologies because computers connect in networks and internet navigation is not a linear exercise (Somekh, Mavers and Rosterick 2002). Kress and van Leeuwen (First edition 2002) explain that concept maps allow a more 'horizontal' view of the ways in which ideas link in contrast to the hierarchical approach of a linear essay. Although this is true of some maps, however, Novak promotes a hierarchical approach to the mapping of ideas. This only confirms that the maps themselves are neutral – they can be used to develop a hierarchy of concepts, or to a flatter and less organised approach.

Concept maps offer the map makers more ways of connecting ideas than an essay. In particular they allow map-makers to define their concepts about digital technologies from a visual as well as a textual perspective. In some cases there will, in fact, be no words only images connected by lines. In this section I also extend the term in the context of concept maps to 'multidimensional concept maps' (MDCM). This term is intended to emphasise the fact that concept maps can be collaboratively designed and remotely authored as well as being produced in many different media.

From these perspectives, I aim to draw out from the literature evidence of the value of concept maps as evidence of understanding and also as a scaffold in developing understanding of digital technologies. I have then reinforced this at several points in this section on the literature'. Seeing concept maps as a holistic multimodal sign highlights a key difference emerging between the traditional Novakian followers and multimodal theorists. Traditional teachers of mapping provide the content of the map, the means of production, the structures to be used and the marking scheme to follow. Then they look for deviations from the norm and judge the value of the map on the strength of the reproduction of given concepts.

The multimodal school, in contrast, value the creativity of the signs they are given. These researchers are learning from the map makers and their interpretation of reality, rather than judging them on what is 'right' and 'wrong'. In this context an analysis of concept maps by a multimodal expert will tend to emphasis an understanding of the map makers' choices rather than testing their recall.

For the educators discussed in this study, multimodality is an important emerging study because it is an illustration of contemporary hybridity and expands across subject disciplines and learning environments.

> Multimodality is central to contemporary conceptions of learning and learning environments (Bezemer, Jewitt, Kress and Mavers, 2008 p. 2.).

Multimodality proves a new perspective on knowledge and communication across the curriculum that extends beyond language. Specifically multimodality includes visual, audio, kinaesthetic communication and representation in linguistics and more broadly the humanities and the social sciences. An understanding of multimodality opens up opportunities for educators to develop their students' capacity in multi-literacies (Jewitt 2002 and 2003). In this comprehensive book, Jewitt brings together a wide range of international theorists that cover the emerging spectrum of multimodality. In terms of multi-literacies the first assumption of multimodality that emerges from this collection of papers is that language is just one part of a multimodal ensemble:

> Multimodality proceeds on the assumption that representation and communication always draw on a series of modes, all of which have the potential to contribute equally to the meaning. The basic assumption 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, 2009 p.1.).

The second assumption is that each mode of an ensemble has been shaped by its social cultural and historical context. The third assumption is that people orchestrate meaning through their selection and configuration of the modes.

The final assumption is that multimodal signs are shaped by the rules and norms of the social environment and reflect the motivations and interests of sign-makers. That is, sign-makers select, adapt and refashion meanings through the process of reading/interpretation of the sign. These effect and shape the sign that is made (Jewitt 2009 p.1). Reinterpreting meaning in this way is popularly called a 'mashup' (see Glossary p. 9). The sign-maker, in this case, has combined similar types of media and information from multiple sources into a single representation. Multimodal opportunities for meaning-making in learning are greatly complicated by the introduction of digital technologies, particularly when much of a students' experience in this field usually comes from outside the school curriculum. In terms of assessment, this raises questions for educators about the value of creating new signs from existing resources that young people find on the internet.

Multimodal theorists, like Jewitt and Kress, have an important role to play in helping educators to explore the difference between traditional education, where literacy privileges writing and multimodal learning, a more informal approach, where many literacies are relevant. Today traditional systems are limited in their range because they only nurture the mono-literate capacity required by traditional reading and writing systems. Mono-literate skills are inadequate for creating or reading a multi-dimensional concept map. This is the reason why the emergent theory of multimodality provides the theoretical underpinning for this analysis.

In this study a particular kind of multimodal sign is used, a concept map, in order to investigate many of these questions about multi-literacies, meaning making and assessment. The term multimodality has been modified to 'multi-dimensionality' here in order to emphasis the specific multimodal affordances of digital maps that differ from hand drawn maps. Multi-dimensional concept maps (MDCMs) might be 'mashups' utilising images, sounds and videos from other sources linked to the nodes (Finch, 2006). MDCMs can be remotely multi-authored and multi-layered. These affordances are highlighted in the term multidimensionality because of their potential in education as innovative modes of collaborative meaning-making, knowledge creation and theory development that digital tools provide. The assumption is that interactive opportunities like these are likely to have significant socio-cultural impact on communication within the professional communities under discussion in this study.

In an interview for an article about the value of concept maps for teachers, Kress (interviewed by Preston, 2007) argues the point that teachers have much to learn from their pupils about semiotics. He explains that in professional terms the link between learning and meaning is very strong – but the full range of semiotic meaning is not just contained in words. Meanings are derived from gesturing, smiling and shrugging the shoulders. Children carry modes of meanings from the world outside school into the school. Kress indicates that concept maps can support learning because they enshrine or encode this world of multimodal meaning that the teacher wants the learners to engage with. Maps are a way to draw attention to the relevance and salient features of the world of the map and the connections of the elements in it. A concept map becomes a particular kind of learning environment – concentrating attention on nuances of meaning in innovative forms.

Buzan's mind maps

The ImpaCT2 team stated that the maps they invite two thousand pupils to draw are more like Buzan's 'mind maps' than Novak's concept maps because they were image based. I contest this point for two reasons. Firstly, the ImpaCT2 team did not teach the students how to draw a

radiant map and ask them to stay with this method. Secondly, the pupils only had paper and pencils whereas Buzan was very keen to introduce colour even in the paper maps that his customers have provided over many years. But Buzan did emphasis the unleashing of the map makers' creativity which is what the ImpaCT2 team also wished to do in the Computers in my World paper exercise.

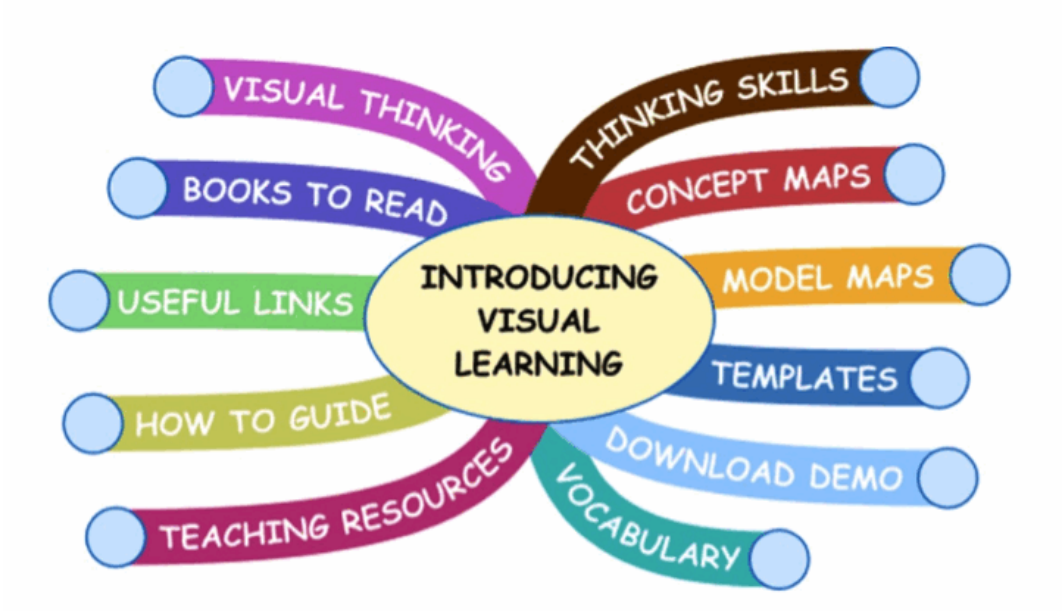

Figure 2.3 - a Buzan style 'radiant map'.

The term 'mind map', trademarked by Buzan (1993) is often used interchangeably with 'concept map' in popular conversation. However, in a 'mind map' ideas radiate in branches from a central idea rather than forming a hierarchical diagram or a network (Figure 2.3).

Buzan was critical of the Novakian method of mapping that he finds too prescriptive (interviewed by Preston, 2007). He saw learning taking place first in images rather than words and insisted that his radiant mind map structure represented the way the mind works (Buzan 1993; Buzan 2002). In his view, the mind map was distinctive because branches radiate from a central node. Each branch can lead to further branches showing how each topic develops in detail. In his theories about thinking, Buzan argued that the brain is a visual image-based thinking organ rather than a language-based organ. In his enthusiasm for the role of shape, colour and curving lines, he argued passionately that images are more important than words in cognition:

> We have been under the misapprehension for 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, nevertheless, a sub routine of thinking (Buzan, 2007, p.10).

There is a strong multimodal current underpinning his view of thinking as image-based and Buzan has some committed followers in business and education. But Åhlberg (2007) offered a word of caution about Buzan's theories on cognition by pointing out that the two research reports about the relationship between Buzan's mind maps and learning (Anderson-Inman and Ditson, 1999; Farrand, Hussain et al., 2002) suggested that the mind mapping process is probably only significantly useful in the field of factual recall rather than higher order thinking.

Multimodal theorists approach to learning

In the interview about the usefulness of mapping for teachers given for this study, Kress questioned Buzan's claim that mind maps detail the workings of the mind (Kress 2007). For Kress this theory was too ambitious. However, Kress did argue that concept maps are innovative because they represent existing modes of thought in new ways. He explained that in the old forms of thinking that emerge from hierarchical organisations, the authority in power tells the learner what they must learn and how. The initial Novakian hierarchical prescription for map construction supported this authoritarian mode of information transmission of scientific or mathematical ideas. In contrast, Kress maintained that power in a contemporary organisation is more horizontal. This means that individuals in that organisation can organise the environment around them according to their own interests rather more like a network than a hierarchical structure. The map makers, in this situation, are not required to reproduce information they have been taught. In the network age learners can set the curriculum agenda by expressing in their maps what they know and what they need to know objectively.

Using scoring for assessing learning

Multimodal theorists are concerned about traditional forms of assessment that purport to be objective, like the scoring of maps that Novak advocated. Kress suggested that concept maps might provide an alternative way to assess meanings that are beyond words and to link assessment more closely to the processes of communication that are prevalent in society (2007).

These ideas about assessment are expanded in Multimodal Literacy, where Jewitt and Kress (2003) contended that new forms of assessment about how learners are thinking should be

created. These should pay attention to the learners' interests, in contrast to tests that exercise power over learners' thinking by insisting on what they must learn. Researching into children's learning in science education Kress, Jewitt et al., (2001) illustrated further this assessment strategy in the significant shift of thinking that takes place in assessing maps about science theories. The researchers began to engage in what underlies and motivates this specific representation of the issue at hand rather than their own preconceptions about what should be on the page.

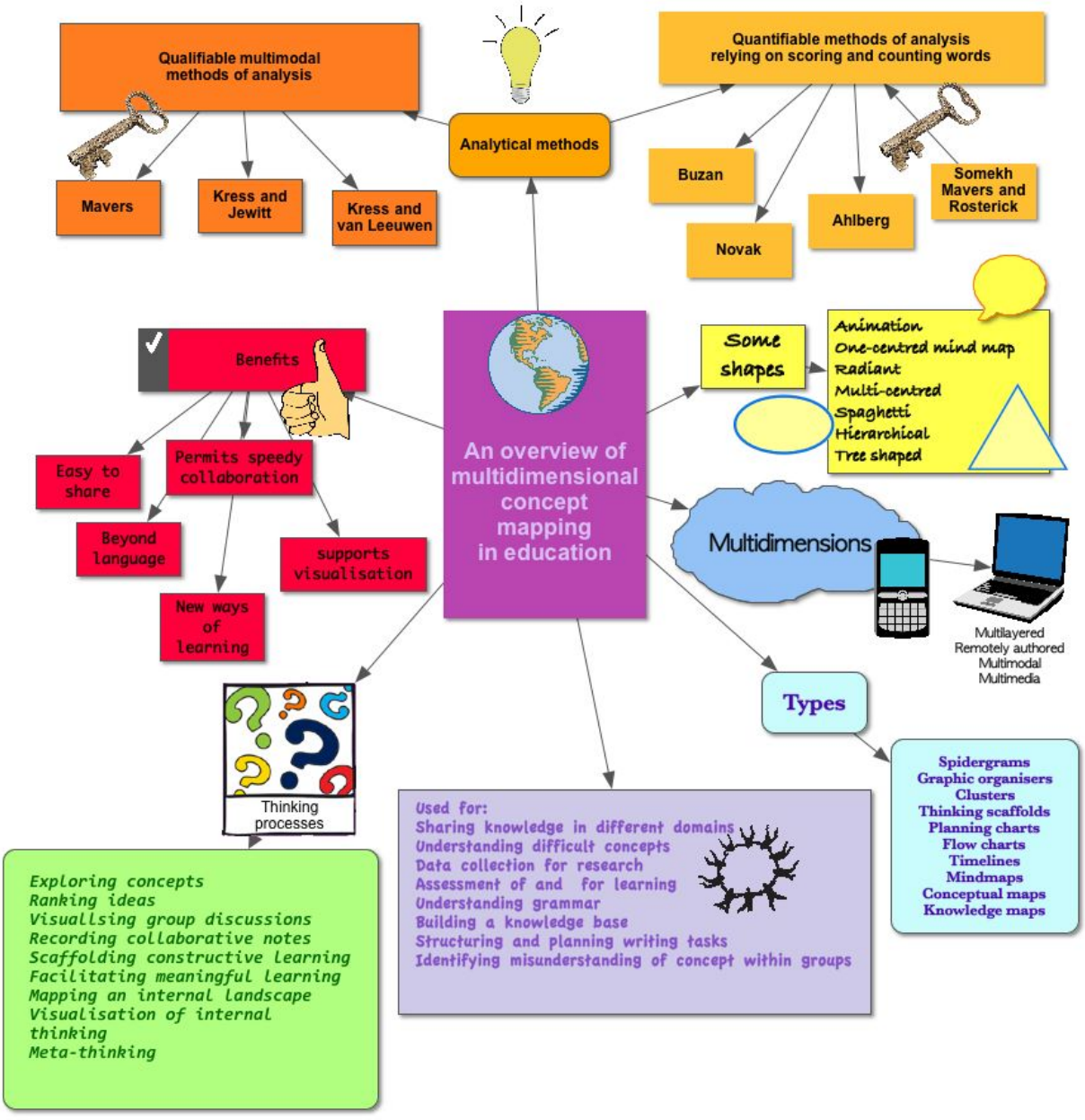

Figure 2.4. A collaborative concept map about concept maps

During their analysis the authors moved from the traditional pedagogical question, did they get this right or not?, - to the learner-centric question – what are the interests the children are expressing here?

Digital multimodal resources

Concept maps can also be produced freely in a wide spectrum of media and in a range of styles as well as in multi-layers of meaning in linked dimensions. They can also be multi-authored remotely which is why I use the phrase multidimensional concept maps (MDCM) to differentiate between what can be reproduced on maps and what can be developed digitally. However, multidimensional concept map is a long phrase and, therefore, in order to help the text flow in this thesis I often used the acronym, MDCM, or sometimes 'multimodal concept map', and, sometimes, concept map or just map. In fact, all concept maps have the potential to be multi-layered and multi-authored depending on what media they are created in. Figure 2.4 shows a multidimensional concept map about concept maps that was developed collaboratively by a group of delegates in my session at the Third Concept Mapping Conference in Estonia and Finland (2008b). This group was interested in the semiotic approach to concept maps that was not, otherwise, in evidence at this 'CMapper' dominated event. This paper version does not permit the demonstration of the layers underneath that hold a variety of notes on the topics. All the notes can be exported into a word processor in linear form to provide the basis of an essay. Figure 2.5 has been reproduced to show, in outline, how secondary school students, working together, have used a Buzan radiant style 'mind map' to develop essay notes on their set play, The Glass Menagerie. The screens are too small to be read in detail, but they are displayed to illustrate how students can manipulate the detail of a collaborative concept map to share different 'takes' on the same information: in this case as a word outline for the planning of an essay and as a diagram that provides a different slant on the relationships in the play. What can be seen is the imaginative use of clip art from the software library as symbols and icons standing in for textual labels that are present even in the outline where text dominates. Pupils who are visual thinkers are likely to find this approach to marking textual ideas helpful. These opportunities to use professional tools give the students more control over the multimodal processes of discourse, design, production and distribution than has ever been possible in classrooms of the past. The value for collaborative work in the spirit of social interaction on the screen is high in terms of class discussion and sharing (Cuthell, 2007; Hennesssy and Deaney, 2009; Leask and Preston, 2011, in press).

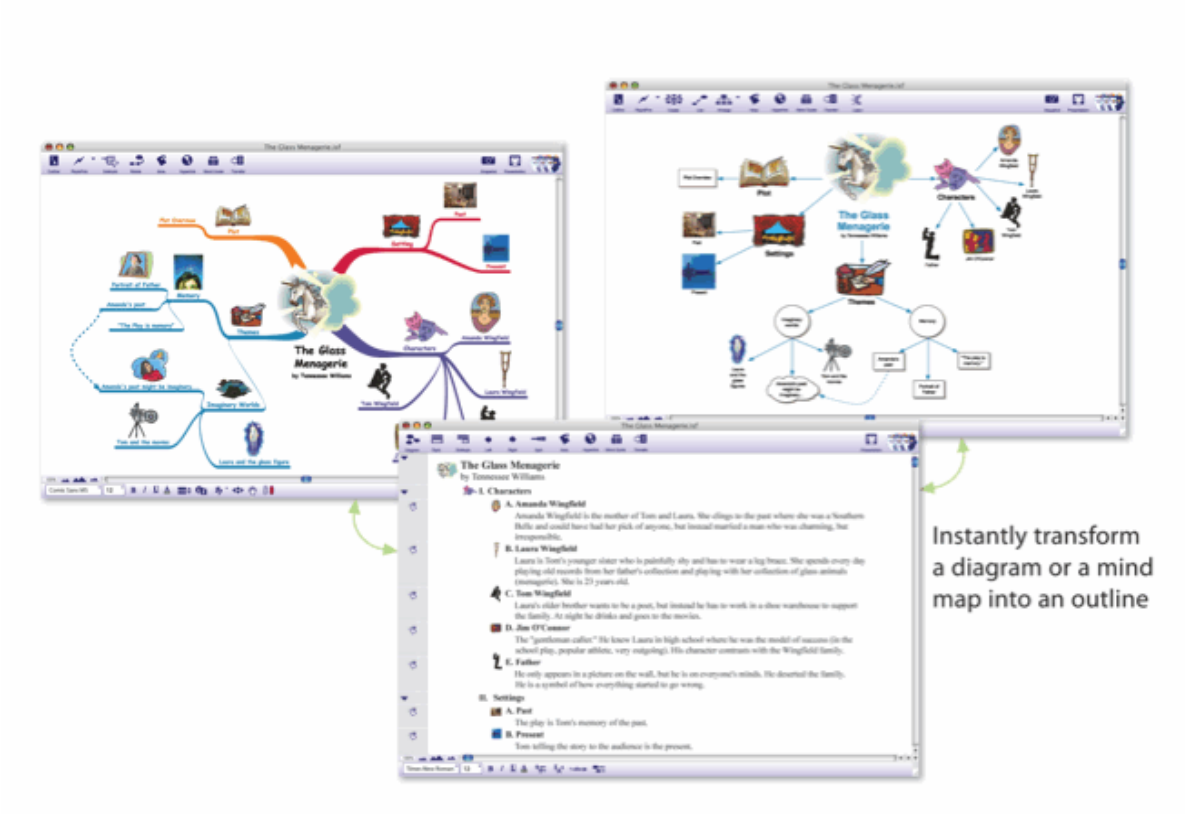

Figure 2.5. Secondary pupils sharing concepts about a play and reproducing them in accordance to the task in hand.

Jewitt (2002) showed that access to digital technologies in classrooms presents learners with multimodal resources for sophisticated meaning making that paper based communication cannot do. Many of the affordances she mentioned are within the scope of a digital concept map. Within the term, multimodal digital resources, she included simulations, virtual learning environments, electronic books, discussion forum applications, spreadsheets, hyperlinks and hypertext. She also cited 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), writing, photos, graphics, sound, animation, texture and multi-layered diagrams that are challenging the dominance of the written word in meaning-making (Jewitt 2002; Jewitt 2003).

Novak speaks against hand-drawn maps because he feels that paper maps are not durable and cannot be changed easily (2010). His team has developed the free 'CMappers' software[3] which now has the affordances of colour and the addition of pictures on the nodes. The examples on the website suggest that meaning is derived from a study of the relative sizes of the nodes and the words inside them as well as the complexity of the hierarchical links. 'CMappers' tends to specialize in complex and expansive digital concept maps to be thrown onto a high wall in

[3] http://www.cmappers.net/

higher education establishments in order to illustrate and discuss complicated theories in science and maths. The teaching appeal of this approach for academics developing difficult concepts is easy to understand compared with a class reporting on their reading of linear papers. These digital maps also reinforce both constructivism and social interactivism in learning if the students are full involved in the creation and critique of the map.

Buzan[4] has a much more commercial following that use these mind maps for personal organisation as much as business gain. On the website, the mind map is promoted for single users and organisations worldwide that can use them 'to revolutionise the way they think, plan, study, create, present and organise.' The marketing language pitches to business offering 'a software solution for boosting innovation and productivity - saving you up to one day a week'. No research is quoted to substantiate this figure.

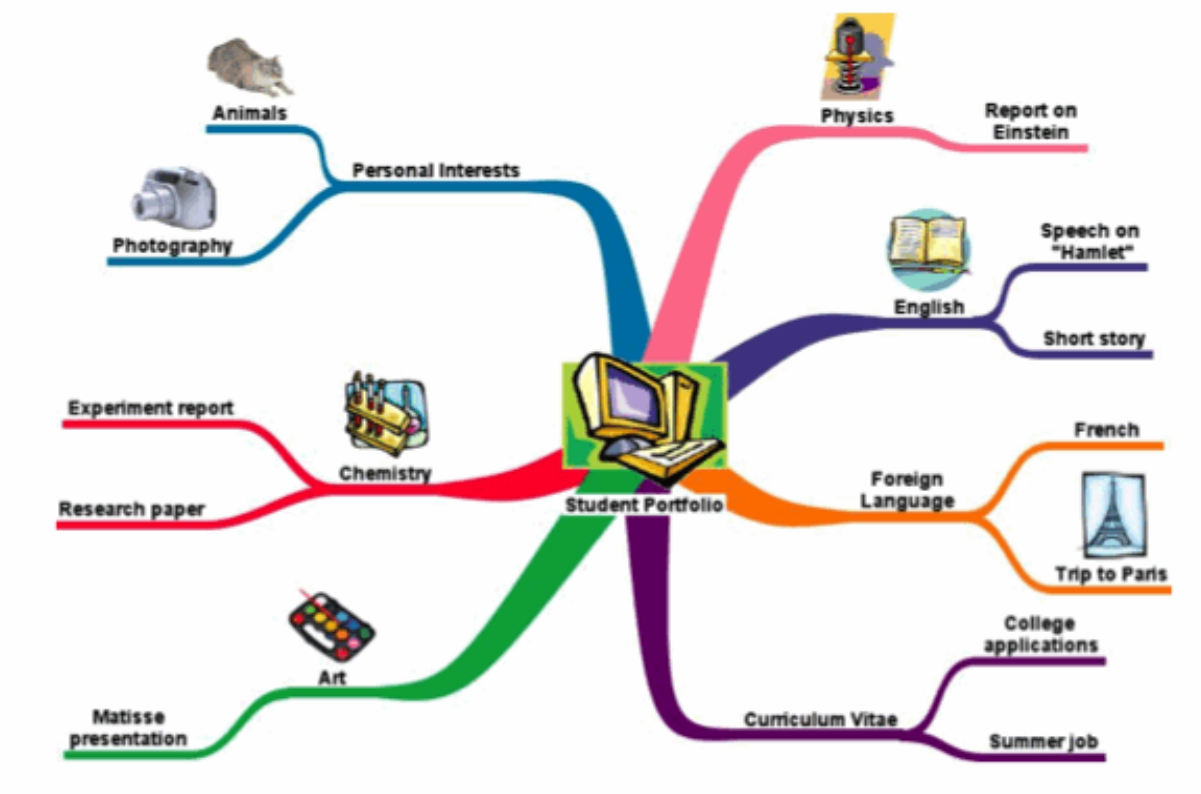

Figure 2.6: a student portfolio in concept mapping style using a Buzan mind map tool

[4] http://www.thinkbuzan.com/uk/

However, the free software that has been developed with Microsoft offers a range of dynamic multimodal features that are persuasive: expand and collapse branches; translate into different views; and, export or import an array of different files, documents and websites. Files, including audio clips and video files as well as urls can also be dragged and dropped onto the Mind Map to make it as interactive and informative as possible. There are galleries of clip art and icons and symbols to make the line of an argument clearer. In Figure 2.6, a secondary student has developed their own portfolio using similar mapping software[5]. This approach to indexing and reporting as a portfolio is substantially different from writing a linear essay on paper. The addition of photos and sound files emphasise the control over different media that this young person is displaying.

Kress and van Leeuwen (2007) anticipated the ways in which concept maps can be used by the learner when they develop the links between computers and concept maps in seeing an affinity between the shapes of maps of associations and the interconnectivity of the internet. They suggested that the concept map form replicates communication modes that are possibly more relevant to all learners today than the linear essay form.

Kress and van Leeuwen suggested that the opportunity to draw a map freely might be particularly relevant to young people because the world is becoming increasingly interested in making lateral connections and network horizontal links rather than prescriptive tree structures associated with hierarchical and vertical lines. This was one of the reasons that the ImpaCT2 team choose mapping as an appropriate mode in which to ask young people to express concepts about computer networks.

[5] http://www.inspiration.com/

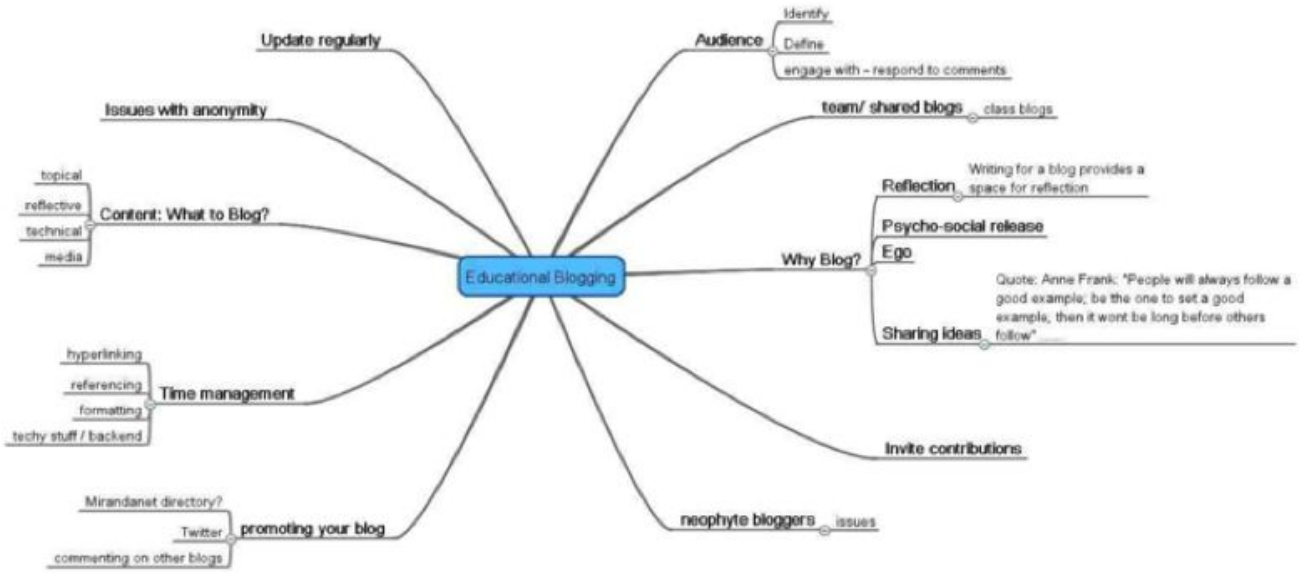

Figure 2.7. A remotely multi-authored multidimensional concept map

Figure 2.7 shows probably the most sophisticated from of complex multimodal sign that has yet been developed. It is best viewed on a screen[6] because maps tend to spread across the landscape are of a screen rather than the portrait shape of a page. On a screen the map maker and the viewer can collapse branches and zoom in and out to read the map more easily. These screen features are beginning to create a communication problem with concept maps used for information that no longer conform to the conventional page.

This multidimensional concept map about educational blogs was developed over a week by educators attending a face to face and online 'unconference' about blogging. At this kind of event social interaction as a form of informal learning is very much in evidence because the learning agenda is decided at the grassroots of the education profession: the power relationships in traditional conferences between expert speakers and learners are destabilised. Teachers in England have led the development of two kinds of 'unconference': the TeachMeet that concentrates on the craft of the practitioner and the international MirandaMod, a themed 'unconference' that encourages a focus on 'praxis' - the melding of learning theory, pedagogy and practice (Preston et al., 2008; Preston 2010).

Mobile digital technologies have made this possible not only in the use of micro-blogging, educational blogs and video connections but also in terms of events facilitated by professional

[6] www.mirandanet.ac.uk/mirandamods

groups. A key element of the MirandaMod digital ensemble is a digital concept map that can be remotely multi-authored by the educators who live in different countries. They use the map to record their immediate professional knowledge about the subject under discussion for other professionals to use. Layers of information are added over the week when the concept map is open that can be in words, images, animation or sound. It is also possible to add notes in languages other than English which is useful if educators are sharing knowledge across national boundaries.

This general trend towards maps that look like networks is spilling over into other kinds of visual representation. In this vein, multi-authored concept maps are created remotely on the web by several map makers in different locations. Collaborative dynamic features were displayed by the Grokker web-service[7], developed by Stanford University. This service, now up for sale, is similar to Google, where searches are presented as mind maps indicating clusters of most prominent and least prominent information as well as information that outside the main field. In a web service of this kind a node on a screen might be linked to another concept map beneath, but each map image will normally be confined to just one more screen. This structure of connected screens, that has become more prevalent with the spread of computers, contrasts with traditional modes of concept communication that favour linear prose.

[7] http://library.stanford.edu/about_sulair/special_projects/stanford_grokker.html (This project has now been closed).