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INTEGRATING KNOWLEDGE, FEELINGS AND ACTION: USING VEE HEURISTICS AND CONCEPT MAPPING IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

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Abstract. Children are nowadays showered with information and knowledge about environmental issues; however, this is very rarely transformed into concerned action probably because the content matter was not meaningful and/or was highlighted at the expense of the more important personalized process of learning. Researchers in Education for Sustainable Development (ESD) reveal that rather than just the acquisition of knowledge, important determinants of commitment include feelings, psychological factors and active participation while learning. Therefore, the misconception that the transmission of knowledge would be sufficient to trigger off an attitude of responsible environmental action has evolved into something more complex where what matters is not *what* knowledge is delivered but *how* it is delivered and experienced. This paper describes the use of Vee Heuristics and Concept Mapping as pedagogical tools, placed within a context of learners' different learning patterns, in a primary classroom. It provides illustrations of Concept Maps constructed before and after the learning programme and discusses some implications of the findings. This paper suggests that the use of Vee Heuristics and Concept Mapping along with an awareness of how the child prefers to learn may be a step towards tapping-in the child's internal talking so that, as educators, we can understand how each learner responds to incoming information so that learning about environmental issues becomes relevant, meaningful and, in the long run, conducive to an improved environmental responsible behavior.

1 Education for Sustainable Development: going beyond transmission of knowledge

In today's world, children are showered with information and knowledge about various issues particularly about the environment; however this is very rarely transformed into concerned action probably because the content matter is not meaningful and/or is highlighted at the expense of the more important personalised process of learning. In this premise, one assumes that what matters is, not ***what*** knowledge is delivered but ***how*** it is delivered and experienced.

As the world's environment seems to be in jeopardy all the time, different forms of Environmental Education (EE) have been readily taken up by educational institutions – the most recent version being Education for Sustainable Development (ESD) – as they were regarded as important strategies in achieving a good quality of life. Although educational programmes have succeeded in providing a vast amount of knowledge about environmental awareness they have very often failed to produce the change in attitudes and values and committed action that was originally targeted by the EE principles proposed by the Tbilisi 1977 Conference (UNESCO, 1980), subsequently confirmed at the Moscow 1987 Congress (UNEP, 1987) and the Thessaloniki 1997 Conference (Scoullos, 1998) and reconfirmed in Ahmedabad (CEE, 2007). Due to the traditional concern of formal education institutions with narrow monodisciplinary structures that promote the transmission of subject content, cognition, i.e. the processing of information or knowledge, was highlighted at the expense of feelings and behaviour (Pace, 2000). Therefore, the misconception that the transmission of knowledge about environmental issues would be sufficient to trigger off an attitude of responsible action evolved into something more complex where, as Orr suggests, "*the way in which learning occurs is as important as the content*" (Orr, 2004:14).

Borden & Schettino (1979, as cited in Newhouse, 1990) also reveal that the more important determinant of commitment (action) was the level of feeling rather than the level of knowledge. Simmons (1991) defined responsible environmental behaviour not only through cognitive factors, but also through conative and affective factors such as problem-solving skills and psychological factors (especially attitudes and the development of self-esteem). Making environmentally responsible decisions requires social and psychomotor skills as well as affective attributes (responsibility and commitment towards sustainable development), i.e. the development of a sustainable development ethic. In turn this is dependant on whether "*knowledge is interrelated to personal behaviour and social values, and if the learner experiences ethical demands in decision making*" (Schleicher, 1996:2).

Chawla (1998) reveals that one of the most important factors of commitment is environmental sensitivity. She describes sensitivity as "*a predisposition to take an interest in learning about the environment, feeling concern for it, and acting to conserve it, on the basis of formative experiences*" (Chawla, 1998:9). Furthermore, Chawla explains that formative experiences may be characterized as exchanges between an external environment (physical surroundings, social mediators) and an internal environment (how the child responds to the external environment). Any effective ESD programme therefore needs to place the learner and his/her personal development at the centre of the learning programme.

2 The Interactive Learning Model: Integrating Cognition, Conation and Affectation

The present study delved deep into the learning process and revealed that if we only look upon cognition, we would be only looking at one-third of who the child really is as a learner. This research highlighted the Interactive Learning Model (ILM) (Johnston, 1996, 1998) which proposes that learning is a process occurring because of the continuous interaction of no less than three mental processes: Cognition (I think), Affectation (I feel) and Conation (I act). Currently, a group of national and international academics along with several hundred school practitioners (teachers, staff developers, and administrators) have worked to develop and test this model of learning. What they have discovered is that the ILM gives teachers, students, parents, and administrators another means of identifying **how** each student processes information, uses her/his personal tools for learning, and develops as a confident and successful lifelong-learner. These researchers and practitioners have observed how the three mental processes of cognition, conation, and affectation, form patterns of behaviour within each learner. These patterns consist of sequence, precision, technical reasoning, and confluence (see Table 1). Furthermore, every learner uses each of these interactive patterns in concert and to varying degrees.

Learning Pattern	**Learner prefers**
Sequence	order, plans, directions, linear logic, continuity
Precision	facts, information, documentation, measurement, correctness
Technical Reasoning	problem solving through design, structure, physical and pictorial representation without the burden of words , use of combat engineering to fix physical/abstract problems
Confluence	risk taking, learning through failure, rapid ideation, extreme imagination, readiness to suspend rules and the limitations of reality in order to move beyond the known

Table 1: Summarised description of the four learning patterns.

To measure the degree to which each learner uses each of the patterns, Johnston & Dainton (2005) developed the Learning Connections Inventory (LCI) which has withstood empirical and theoretical testing for more than ten years in different countries around the world. The LCI consists of two parts: Part One consists of 28 descriptive statements which the learner reads and then indicates his/her responses on a 5-point numerical continuum and in Part Two the respondents are asked to answer 3 open-ended questions. The LCI scores reveal whether one uses a learning pattern at a "Use First" level, "Use as Needed" level or seek to "avoid" it altogether.

Figure 1 shows that information enters the brain through our sensory systems and some of it is processed in our working memory. Some of this information is stored for future retrieval in our long-term memory. Bruer compares our working memory to "*a computer's central processing unit*" while he compares our long-term memory to "*a computer's hard disk*" (Bruer, 1993). He further suggests that cognitive psychologists reveal that long-term memory comes in an array of structures and they distinguish between declarative memory which stores facts and events and non-declarative memory which stores skills and procedures. Nonetheless, unlike a computer we do not retrieve information by giving it "*an address*" in our brain but by creating associative links between chunks of information. This suggests that new learning is integrated into pre-existing structures which psychologists call *schemas*. These pre-existing structures effect how we process and interpret incoming information. Bruer argues that "*prior knowledge affects how we interpret school instruction and thus affects what we can learn. School instruction that ignores the influence of pre-existing knowledge on learning can be highly ineffective*" (Bruer, 1993:28) and, we add, potentially damaging to a student's plans for further education as success within the system is dependent not on the competency of the learner, but on his/her ability or inability to adapt to the 'set menu' offered by the school.

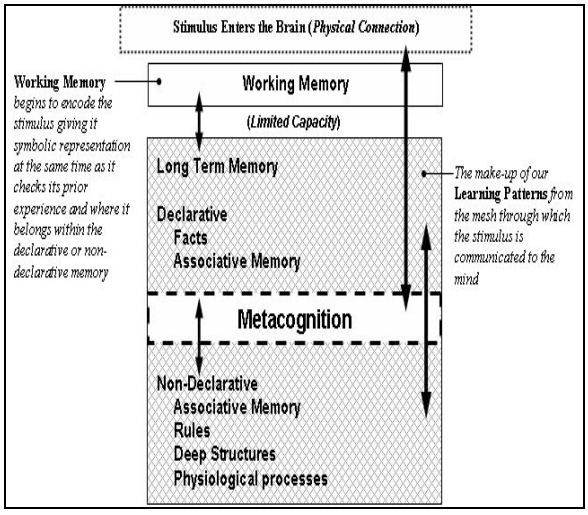

Figure 1: The LML Representation of the Architecture of the Brain and Mind. (after Johnston, 2005)

Similarly, the ILM suggests that when a stimulus enters the brain, the brain sends neuro impulses to the mind which translates the impulses into symbols that it can store, process and retrieve while at the same time it checks its prior experience and where it belongs within the declarative or non-declarative memory. This is where Metacognition comes into play. In fact, it is suggested that it is through metacognition that these symbolic representations are transferred into the non-declarative memory. More importantly ILM suggests that our learning patterns form the filter through which the stimulus is communicated to the mind when we are learning i.e. one responds and interprets incoming information through these learning patterns which occur differently in each learner.

Metacognition is an intrapersonal communication where time is given to quietly think and reflect on what one is learning (Vanhear & Borg, 2000). Behaviourist models emphasise the multistage model of memory where practicing past tasks leads to over learning which results in resistance to extinction (Vanhear & Borg, 2000:10). This model clearly promotes rote learning. However, ample research in this field (for example; Freire, 1970; McLaren, 1989; Novak, 1984,1998); reveals that the cognitive key to retention is meaningfulness. In other words, research is distinguishing between neural patterns stimulated by simple reaction to stimuli and those constructed from reflection. One of the ways in which rote learning is challenged is through metacognitive instruction (Novak, 1998; Bruer, 1993). Metacognition challenges the transmissive views of learning and teaching held by certain teachers and perceptions about the passive role of learners. This is because metacognition lends itself to a process of praxis (Vanhear, 2006). The equation is as follows: "*by being reflective, revisiting the learning process making comparisons between prior and current conceptions, and being aware of and analysing difficulties, learners gradually maintain deeper understanding of the learned material … maintaining better understanding sets the bases for successful transfer*" (Georghiades, 2000:128).

3 Methodology

On the basis of the theoretical background presented above, the following research question was constructed; how can teachers help learners to reflect upon their knowledge and experience of the environment and to act upon these by helping them construct new meaningful knowledge? This research question revolves around the notion of the learners' structures of knowledge and how they respond to it or as Gardner (1991:253) argues "*we must place ourselves inside the heads of our students and try to understand as far as possible the sources and strengths of their conceptions*". This is also what Bruner (1996:49) sought for throughout his studies "*I have long argued that explaining what children do is not enough; the new agenda is to determine what they think they are doing and what their reasons are for doing it*".

In this premise, this research aims to make use of two validated tools namely: Vee Heuristics and Concept Mapping in a primary classroom to improve on meaningful learning of specific environmental knowledge related to biodiversity. For this study, nine students (all girls) with different learning patterns were chosen randomly using the LCI. Although nine girls were selected for an indepth study, the whole class participated in the whole procedure and learning programme of this research. A semi-structured interview was carried out with these nine learners to find out details about their knowledge and misconceptions about the chosen topic and how these developed to construct new meaningful knowledge. Vee Heuristics were used by each child to chart her individual learning experience. Since Gowin's original Vee was too complex for 6 year olds, the study opted for Ahoranta's adapted version of Åhlberg's improved Vee Heuristics (Åhlberg & Ahoranta, 2002) to trace the learning process. Concept Maps were constructed by the children **before** and **after** the learning process and the differences that emerged and their implications were discussed with the children. The different learners' learning patterns shall be taken into consideration, discussed and evaluated whether they contribute to diverse structures of knowledge.

4 Data Analysis

The paper will now present, analyse and discuss in detail the learning patterns of two learners with two different learning profiles.

4.1 Maria (her LCI scores are summarised in the grid below)

Learning Pattern	LCI Score	Preference
Sequence	16	Avoid
Precision	22	Use as Needed
Technical Reasoning	27	Use First
Confluence	20	Use as Needed

The LCI score presented above exhibits a 'dynamic learner' (Johnston, 2005) who makes use of Technical Reasoning at a Use First level. She uses her Confluent and Precise processing as needed while she avoids Sequence processing. From this learning pattern, one can deduce that Maria doesn't like to write in detail, she makes use of very few words to express herself, she prefers to work by herself and needs to see the purpose for what she's doing. Furthermore, she tends not to read directions since she finds following directions quite confusing if not frustrating (Johnston, 1996, 1998).

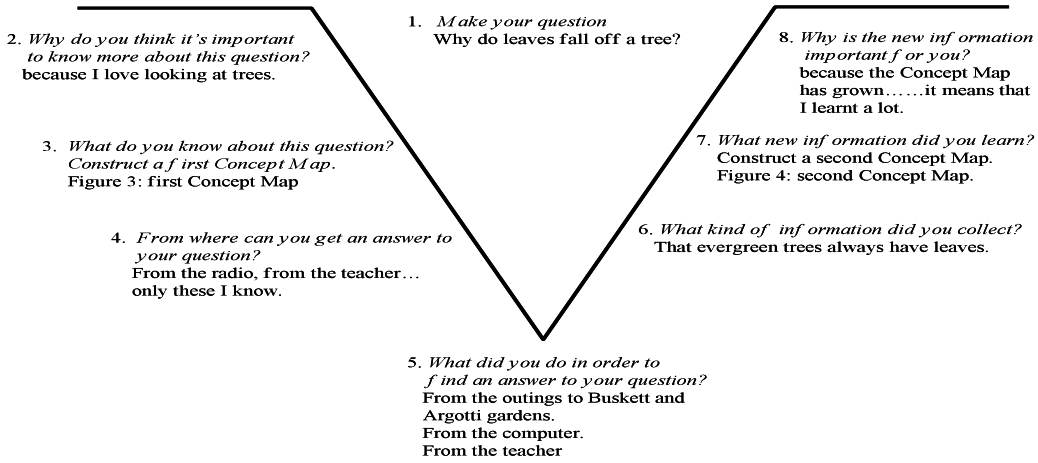

Figure 2: Maria's Vee Heuristic

The responses exhibited in the Vee Heuristic presented in Figure 2 correspond to this learner's learning patterns. Reply to question 2 is clearly conveying that scoring high in Technical Reasoning, this learner looks for relevance and practicality for her learning to occur. Children who score high in Technical Reasoning don't feel comfortable in traditional classroom settings since their learning doesn't occur through the use of pen and paper, therefore, they very often regard themselves as 'non-learners' since they feel that they do not fit in the class, in fact Maria's response to question 4 shows that she was hesitant and unsure. Her instant reply "the radio" stands for an outside the classroom setting while "the teacher" represents this learner's Sequence in the "use as needed" level. The response to question 5 was immediate and sure thus showing an increase in this learner's self-confidence and motivation along the learning programme. It also reveals that her primary sources for learning were the computer, where she had time to figure things out on her own, the outings which presented hands-on experiences (Technical Reasoning) and from what the teacher told her (Sequence). The difficulty this learner encounters when trying to communicate what she learnt is shown in her answer to question 6, in fact, she only mentioned one aspect of her learning whereas, if we observe her second concept map in Figure 4, we can easily note that this concept map reveals more about her learning than what she was able to express in words. It is worth giving some thought to the reply to question 8 where Maria stated *"because the Concept Map has grown"*. Actually, this learner was enjoying altering and adding to her first Concept Map although she needed guidance in parts of the map especially when it came to cross links.

During the interview referring to her response to question 8, Maria was asked *"What does that mean?"* she eagerly replied that *"It means that I learnt a lot"*. As previously stated, highly technical people who also score low in Precision are very often labeled as "non-learners" since they find it very difficult to express and communicate what they learnt through paper and pencil requirements. Therefore, this reply evidences that she was satisfied with herself for being able to visually express what she had learned.

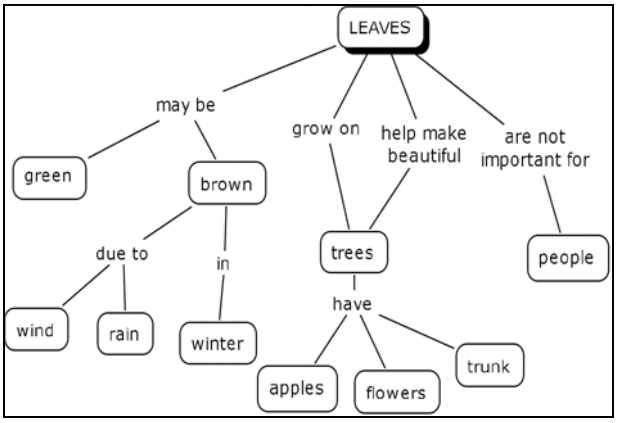

Figure 3: Maria's first Concept Map before the learning programme

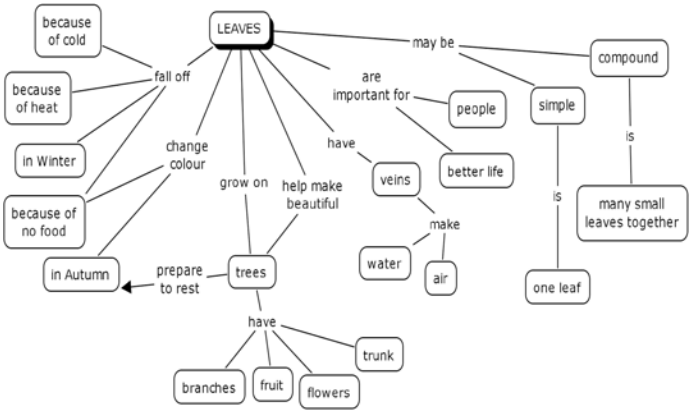

Figure 4: Maria's Second Concept Map after the learning programme

When comparing the two Concept Maps presented in Figures 3 and 4, an increase in concepts and propositions is easily noted, showing that learning has taken place. Being an abstract concept and highly technical learners don't normally do well with abstractions especially in the classroom setting, it can be concluded that the second Concept Map demonstrates a high ability in learning new concepts and a readiness to change previously held knowledge while also exhibiting an increase in the learner's motivation to learn and to express it in this way. Furthermore, much of the new knowledge learnt represented in her map such as *"leaves may be compound like many small leaves together"*, *"leaves may be simple that is one whole leaf"*, *"leaves are important for a better life"*, *"leaves have veins"* and *"trees prepare to rest in Autumn"* were all concepts which were delivered through the guided walks in Buskett and Argotti gardens. Maria also changed her misconception that *"trees have apples"* to *"trees have fruit"* while also changing that *"leaves are important for people"*. As exemplified by this latter case, she also showed instances where she extended instances in which she made value judgments. Finally we can also note the addition of propositions related to the focus question *"Why do leaves fall off a tree?"* Therefore, prior knowledge was developed; misconceptions were altered and new knowledge constructed.

4.2 Rita (her LCI scores are summarised in the grid below)

Learning Pattern	**LCI Score**	**Preference**
Sequence	28	Use First
Precision	26	Use First
Technical Reasoning	21	Use as Needed
Confluence	16	Avoid

Rita's LCI score reveals that she "uses at first" level her Sequence and Precise patterns, the Technical Reasoning pattern is "used as needed" while she "avoids" the Confluent pattern. This means that this learner needs clear step-by-step directions; she wants to do her work neatly and wants to know whether she's meeting her teachers' expectations. She also tends to want thorough explanations and asks a lot of questions. She likes details and she prefers written work to show what she has learnt. When needed she can also learn through hands-on experience, while, on the other hand, this learner avoids taking risks and prefers her work to be as accurate and as correct as possible.

Rita's Vee Heuristic (Figure 5) discloses a lot of useful information about how she prefers to learn. The left hand side reveals why is it important for the learner to want to know more.

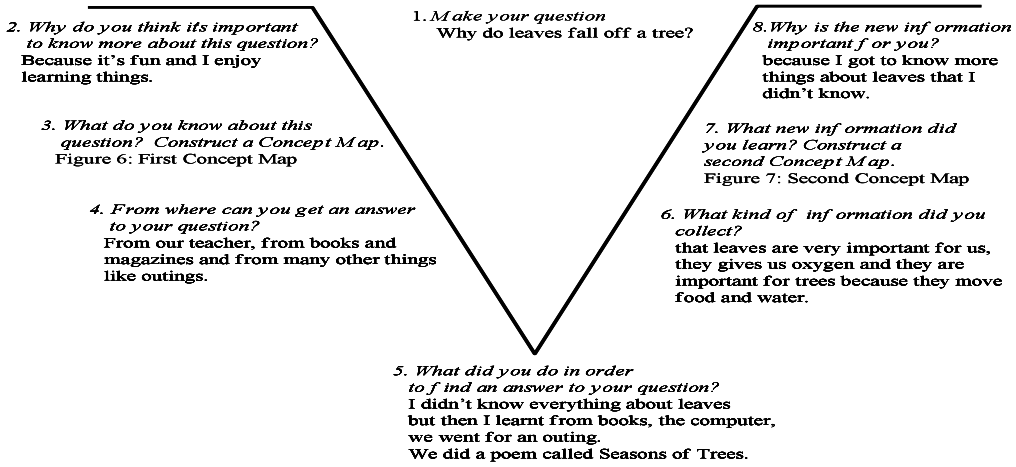

Figure 5: Rita's Vee Heuristic

Furthermore, her reply to question 4 conveys how she plans to learn and with the knowledge of how her learning patterns work most efficiently for her, both the teacher and the student can together build a learning programme which would make sense to the learner. Rita plans to learn through books and the teacher (Sequence and Precision) but also through outings (Technical Reasoning). Her learning patterns are evidenced also in her reply to question 5 which shows what the learner actually did in order to learn, and this substantiates her learning patterns since she mentioned books, the computer, the outing and also a poem.

Therefore, her primary sources for learning occurred in the classroom setting but having a score of 21 in Technical Reasoning where she makes "use as needed" of this learning pattern, she also mentioned the outing as another source for her learning. The right hand side of the Vee Heuristic exhibits how the learner constructed and developed her knowledge. Her reply to question 6 shows that she developed her knowledge about the importance of leaves as exhibited in her second Concept Map presented in Figure 7. In question 8 she was able to compare her prior knowledge with the present knowledge and in fact, learners with this kind of learning pattern are very good in comparing.

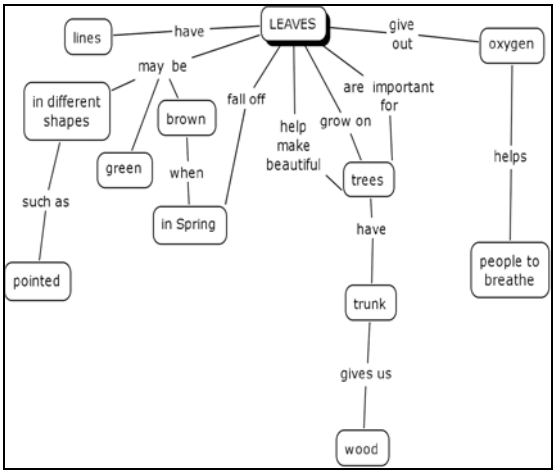

Figure 6: Rita's First Concept Map **before** the learning project

By comparing the Concept Maps in Figures 6 and 7 which were respectively constructed before and after the learning programme one can easily note an increase in concepts and propositions where prior knowledge was developed, misconceptions were corrected while new knowledge was constructed. This learner went into greater detail in her second Concept Map like for example to the concept *"different shapes"* she added *"compound", "simple", "narrow"* and *"wide",* or to the linking phrase *"fall off"* she added four other different appropriate concepts. She was also able to correct her misconception that *"leaves fall off in Spring"*. One of the most remarkable details was that she was able to exhibit the proposition *"in Autumn comes out* [they show] *their real colour such as red, orange, yellow".*

5 Discussion

This research challenges conventional and restrictive classroom practices that emphasize rote learning at the price of meaningful learning because learners are considered passive recipients rather than dynamic actors who commit themselves to thinking, acting and learning critically. The data collected in this research reveals that each learner processes incoming information differently and it is very unrealistic to expect that all children respond to whatever happens in class in approximately the same way. Furthermore, it reveals that different learners learn in different settings and therefore not all learners learn best in a non traditional setting and vice-versa (Zelezny, 1999). The results confirm that for a learner "*to take interest in learning*", the teacher must be aware of the learner's own preferred way of learning in order to address his/her needs and enhance his/her

learning experience. This is where the ILM can be valuable since it reveals how each learner prefers to learn and how he/she responds to incoming information.

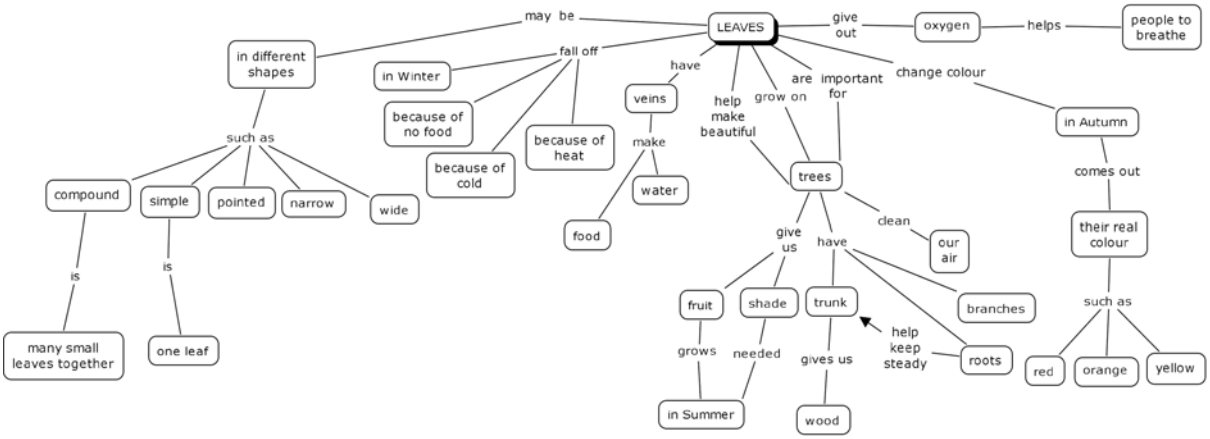

Figure 7: Rita's Second Concept Map **after** the learning programme.

The Vee Heuristic lent itself beautifully for a process of reflection and action where the child's internal talking became visually overt and explicit. In this way learners are taught to think aloud and reflect on what's going on in their heads and how they can proceed to act and develop it. Research has shown that new meaningful knowledge does not occur in a vacuum (Bruer 1993, Johnston 1996, 1998; Novak 1998) and thus prior knowledge has to be taken into consideration if we expect meaningful learning to take place. By constructing Concept Maps for the focus question under study, the children clearly conveyed at a glance, "*what they already know*" thus providing educators with the opportunity to build upon it. The two Concept Maps constructed before (on the left hand side of the Vee) and after (on the right hand side of the Vee) the learning programme were very effective in allowing both the teacher and the learner to easily see what prior knowledge was present, what new knowledge was learnt and how this was integrated within the pre-existing cognitive structure and elaborated. One has also to bear in mind that for learners who are used to learning through rote or memorisation of facts, Concept Maps may offer quite a challenging task at first and it may take some time before they feel comfortable working with them.

The integration of these metacognitive tools: the Vee Heuristic, Concept Mapping along with an understanding of how the learner prefers to learn, provided the teacher (and the learner him/herself) with a clear picture of how the learner responds to and acts upon incoming information. These metacognitive teaching strategies shift the control from the teacher to the learner (Bruer, 1993). Consequently, learners become the agents of their own learning since they are actively participating in their own learning process. Moreover, the learner exhibits how he/she plans to learn more and this is very important for the teacher to be able to collaboratively build a learning programme which would be relevant to the learner's way of responding to new information and thus prove to be truly motivating and meaningful.

6 Conclusion

ESD promotes a particular lifestyle which highlights not only knowledge but also feelings and attitudes that call for commitment and responsibility towards sustainable development. It is dependent on informed action and the development of autonomous critical learners. The methodology proposed by the study proved to be an effective way of giving the learner ownership of learning in a way that s/he is conscious of how s/he is learning and thus can direct (i.e. is empowered) its course. A paradigm shift has to occur in the way we see things, prevailing discourses have to be questioned and this is why various authors (O'Sullivan, 1999; Orr, 2004; King, 2005) are now calling for a transformative vision of learning – not just the transformation of students into functional citizens, but also the transformation of the learning institutions themselves to provide these enabling pedagogies. Effective ESD at formal education institutions is dependent on a change in praxis; and change is not always a welcomed alternative. Consequently, alternative methodologies are viewed with suspicion and need to be acknowledged and legitimized within the institutions' administrative structures for them to proceed.

Consequently, alternative methodologies are viewed with suspicion and need to be acknowledged and legitimized within the institutions' administrative structures for them to proceed.

Concept Maps and Vee Heuristics lend themselves for this process of transformation for both the teacher and the student. It is a process through which the prevailing model of education is challenged. This research has shown that the use of these two tools facilitates the achievement of ESD targets and may, in the long run, bring about the desired environmental responsible behaviour. This is because these two tools present a process of praxis and through their use learners are trained in decision-making, reflective and problem solving skills by effectively identifying the child's "internal environment" and leading them to understand what is going on in their heads and why and how they respond differently to different situations. However, the characteristics of and how this translates from meaningful knowledge to responsible environmental action needs to be studied further. It is not what we teach them that matters but how they will respond to it. This paper is just a very small part of a larger research project presented as a Masters in Education Theses for the University of Malta (Vanhear, 2006).

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