JOURNAL
OF BALTIC
SCIENCE
EDUCATION

ISSN 1648-3898

THE IMPACT OF SITE-VISITS ON THE DEVELOPMENT OF BIOLOGICAL COGNITIVE KNOWLEDGE

Miriam Muscat,
Paul Pace

Abstract. *Classroom-based science teaching tends to be dominated by teaching that stifles the students' natural curiosity and eagerness to discover their surroundings. Knowledge makes sense to students particularly when it is learned within the context of an authentic experience. Thus classroom-based science needs to be complimented by out-of-classroom activities which offer direct and relevant information that influences students' learning. Students build new knowledge on already existing schema, thus it is important for both teacher and students to question and evaluate their knowledge to be able to build on solid grounds. This paper illustrates examples of meta-cognitive tools (i.e. Vee diagrams and concept maps) used before and after site-visits to explore the contribution of out-of-classroom activities to the students' biological cognitive development. This research shows that site-visits are a necessary part of science learning because they help students develop observational and reasoning skills, link biology to personal life experiences and contextualise inert classroom knowledge, making it more meaningful and easier to remember.*

Key words: *concept maps, meta-cognitive tools, out-of-classroom activities, site-visits, Vee diagrams.*

Miriam Muscat, Paul Pace
University of Malta, Malta

Introduction

In today's society, science education has a large responsibility to promote public understanding of science, prepare students to work in a scientific and technological world and provide scientifically literate citizens equipped with reasoning and literacy skills needed by 21st century citizens, able to take informed decisions and deal with scientific issues (Woolnough, 1998). Millar & Osborne (1998) acknowledge that a reform in the science curriculum and delivery system needs to be implemented so as to meet the needs and demands of a changing world and address and hold the interest of all the students, rather than a little minority who aim to be future scientists. This paradigm shift involves giving students the opportunity to build their own meaning and understanding of their surroundings through authentic science experiences.

Rather than rooting science teaching in the classroom, it should be acknowledged that learning is not confined to school hours but is a continuous and lifelong process. Much of what is learned in formal settings is built on cognitive frameworks constructed during informal experiences and these activities affect the students' ability at school and their functioning in society (Gerber, Cavallo & Marek, 2001).

Access to community resources, such as science centres, museums, botanical gardens, libraries and work with non-governmental organisations (NGOs) and community organisations offers accurate, current and relevant information that makes science more valid and stimulating for the students (Falk & Dierking, 2000). These experiences help students grow into self-confident, autonomous, socially-minded learners who integrate their personal and public science knowledge by building on their personal experiences through genuine exploration (Woolnough, 1998; Braund & Reiss, 2006a).

ISSN 1648–3898

Much of the information required in daily life is not textbook bound, but is topic specific and highly influenced by the individual's career needs and interests. Given that school is not the primary source of knowledge for learners and that students can obtain information from a vast array of resources, even before they start school, out-of-classroom activities play a fundamental role in providing a diverse and innovative style of learning, by providing direct experiences of concrete phenomena, real objects and persons, helping students to contextualise scientific knowledge and understanding and contributing to science learning as schools do.

Brighouse (as cited in May, Richardson & Banks, 1993, p.2) claims that 'one lesson outdoors is worth seven inside'. Out-of-classroom activities that complement classroom practice expose students to the actual world (fieldwork), the presented world (visits to botanic gardens) and the virtual world (watching videos) (Braund & Reiss, 2006b). This helps give a faithful picture of science at work, scientists in action and how science can help to solve real-life problems.

Piaget (as cited in Gerber, Cavallo & Marek, 2001) explains that direct experience, cognitive conflict and social interaction help learners construct knowledge, helping them to interpret the external world in terms of their current schemas, reinforce existing knowledge and build additional knowledge. Dewey (1938) gives central importance to direct experience which drives learners to question and investigate. Interest-triggered learning activities facilitate the transition from lower-order learning like simple memorisation to higher order cognitive learning strategies needed to tackle abstract concepts (Orion, 1993; Krapp, 2002). Situational interest created on site is emotional in nature and even though it can have a short term impact on the learner, it can gradually develop into personal interest which facilitates understanding and integration of concepts that are more long-term (Pavin & Stephenson, 2004; Uitto, Juuti, Lavonen & Meisalo, 2006).

Learning on site (i.e. learning outside the classroom on chosen premises) is different from learning in any other setting, due to the unique nature of the experience and the multiple stimuli to which students are exposed (Falk & Dierking, 2004). The diversity offered during out-of-classroom activities not only engages learners with different strengths and interests, but it also provides opportunities for students to learn in multiple modes, reflecting Gardner's pluralistic view of the mind (1993). Oppenheimer (1986, p.6) 'views a science museum as a collection of props that constitute an interlocking web of mini curricula', where sensory modes of experience including visual, auditory, tactile, smell and even taste attract different learning patterns (Borun & Dritsas, 1997).

Each individual's experience is unique and depends on a collection of factors ranging from the multiple histories which form the character, behaviour and learning style of the student (Falk, 2004) to the group interactions on site, prior knowledge, reasons for visiting the site and what is done before and after the visit. In the words of Falk & Dierking (2002) 'learning begins with the individual. Learning involves others. Learning takes place somewhere' (p.36). These statements capture the contextual model of learning which consists of 3 overlapping contexts:

1. personal (learner's background: previous experiences, interests and current understanding of the topic);
2. physical (layout of the venue and labelling available); and
3. sociocultural (interactions with other people).

The learner's agenda is dominant in such sites and determines the level of involvement in the activity. Shortland (1987) argues that clashing students' and teachers' agendas make it difficult to reconcile learning and entertainment and sustains that 'when education and entertainment are brought together, education will be the loser' (p. 213). Falk, Coulson & Moussouri. (1998) counter argue that a mixture of motivation for education and entertainment provides the most significant learning gains. Intrinsic motivation evoked by personal interest, the joy of the experience itself and having learners emotionally involved in the experience provide more cognitive gains than extrinsic motivation like passing an exam (Salmi 1993 as cited in Braund & Reiss, 2006b; Csikszentmihalyi & Hermanson, 1995).

Out of classroom activities are an effective tool to enhance academic learning not only to break the monotony of sitting passively reading and writing, but because students are engaged in visual and kinaesthetic modalities simultaneously. The more channels are provided for students to connect to personal experiences the more is long-term memory facilitated (Woerner, 1999). Facing new experiences helps each learner retrieve past experiences from memory and reconstruct knowledge making better meaning of past and present concepts (Rennie, Feher, Dierking & Falk, 2003). Learning is a lifelong process; it does not begin and end with the site-visit itself and students may understand future experiences by linking them to knowledge acquired on site.

It is wrong to assume that a topic, once covered in class, will be permanently stored in memory and available in other contexts. In class, most topics are taught in a decontextualised setting and most of the information given remains meaningless to students. Given that learning is so context-dependant, out-of-classroom settings provide a means to facilitate the transfer of knowledge to different contexts so as to relate what is being covered in class to a relevant physical context.

Research Methodology

This research explored if out-of-classroom activities complementing classroom practices enhanced learning and understanding of biological concepts among sixteen year old students and observed their attitudes towards sites of biological importance.

The research tools used during this exploratory research included meta-cognitive tools, namely Vee diagrams and concept mapping, together with class discussions and interviews. Eighteen students took part in this research. Due to time constraints, only four students were interviewed and each interview was later transcribed. Interviews and class discussions allowed more indepth understanding of the students' cognitive development throughout the process.

The original Vee presented by Gowin was judged difficult to tackle with students; new to this procedure, thus a simpler version of the Vee, devised by Ahlberg & Ahoranta (2002), was used for this study (Figure 1). Concepts maps were constructed by the students before and after each site visit and biological knowledge in both was compared.

The criterion for choosing the sites was mainly based on whether the site's theme fitted the topic being tackled in class. A visit to the greenhouses was organised when 'nutrition in plants' was tackled and a visit to the blood bank was linked to 'transport in humans'.

Dillon (2006 p.110), points out that "to be effective, fieldwork needs to be carefully planned, thoughtfully implemented and followed up back at school". Thus, before each site-visit the premises were visited and the persons in charge (guides) were briefed about the students' current knowledge, their misconceptions and the aims of the visit. This helped the guides feel more self-confident with post-secondary school students and allowed them time to plan beforehand the points that needed to be addressed during the visit.

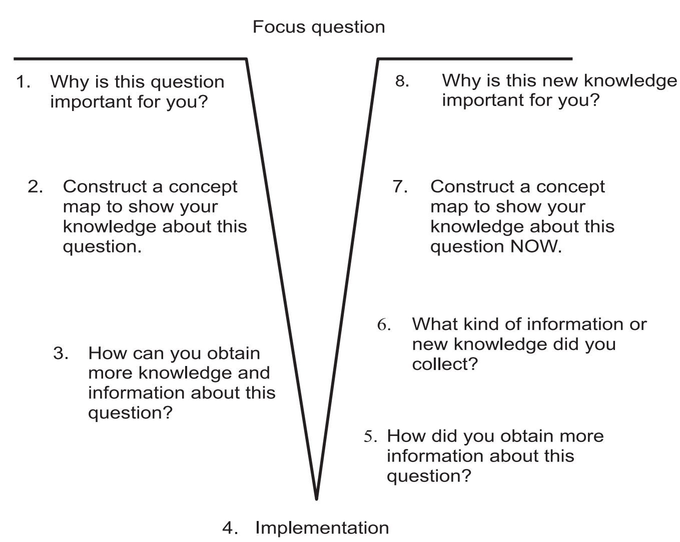

Figure 1: Vee diagram used during this research

ISSN 1648–3898

In preparation for the implementation of the research methodology, the first scholastic semester was used to help the students familiarise themselves with concept maps by drawing simple concept maps related to topics they were familiar with. Data collection started during the second semester and involved three main stages, which are described below:

Pre-visit Activity

Students were introduced to the focus question and were given the questions forming part of the planning phase (left-hand side) of the Vee diagram, which included drawing a pre-visit concept map. Worksheets were collected and a class discussion was carried out to obtain immediate feedback from the students and four students were interviewed.

Implementation Phase

Each visit was planned for about two hours in the morning; enough for the guide to provide all the necessary information and tour us around the premises, yet short enough to prevent students getting annoyed and lose interest due to hunger or tiredness.

Post-visit Activity

A class discussion probing into the students' feelings and reactions was carried out immediately after each visit. The students were given the questions forming part of the evaluation phase of the Vee (right-hand side), which included drawing a post-visit concept map. The same four students were re-interviewed. The pre and post visit concept map of each student was then compared and analysed.

Research Results

One immediate result observed during the class discussions was that different students were attracted by different aspects of the visit and had varying opinions on issues which emerged from the visit. In the following section, the development of biological knowledge will be discussed through some of the students' concept maps and Vee diagrams.

Students Attitudes towards Site-visits

Prior to experiencing their first visit, none of the students considered an out-of-classroom activity as a possible source of further information in question 3 of their Vee diagrams (see Figure 10). The majority of students considered '*experiments*' as a possible source of information. They explained procedures that they may have carried out during their secondary education course since no practical work is carried out at intermediate level and these procedures were not mentioned in class. Students could not suggest other innovative sources of information to learn more about plants. Further discussion in class led students to broaden their spectrum of ideas and they eventually mentioned '*asking people at plant research centres*' and '*visiting nature reserves*'.

For the other visit, students ignored the existence of a blood bank and linked blood donation to mobile units that travel from village to village. Possible venues suggested by the students to learn more about blood included visits to hospitals or inviting surgeons to talk about their experiences in class.

After the visits, students explained that direct observations on the premises, watching the processes *'really taking place'* was better that *'watching a film'*. *'Living the atmosphere'* on site, *'watching people at work'* and using the senses made the topics *'more interesting and easy to remember'* than sitting passively in class taking notes. Moreover, certain issues would have been impossible to learn in class. Students said that the visit to the greenhouses helped them consider the world of plants more positively and that the guide's anecdotes – obtained through years of experience – provided insights that could not be found in books.

Students' Images of the Premises

Most of the students' ideas about both sites were influenced by hearsay, TV episodes of popular programmes and pictures they watched on internet, books or magazines.

The ideas about greenhouses ranged from their structure to the practices carried out inside them. Students imagined greenhouses to be '*always closed*', like a '*controlled environment where you can adjust yourself*', where '*the amount of light can be amplified*', '*humidity and temperature are controlled*' and where *'farmers use sensors to increase the carbon dioxide levels'*. Some students thought that inside a greenhouse no pesticides are used since there are no pests; '*plants grow in rows which can be easily accessed*'; '*different kinds of fruit can grow out of season*' and that '*only vegetables are grown*' since flowers '*would be grown outside because of pollination and direct sunlight*'

The students generally had a negative image of the blood bank. They considered it a kind of hospital where doctors and scientists work in an impersonal atmosphere, a '*depressive place*' where the blood donation process is lengthy and where '*people have a lot of bruises after giving blood*'.

After the visit, the students' ideas of both premises changed. They realised that greenhouses are used to grow both vegetables and flowers; that greenhouses can be left open to allow ventilation to take place and that insects can enter inside the greenhouse to aid pollination. They were surprised at the friendly atmosphere at the blood bank where '*they* (nurses) *welcome you and talk to you, then you can eat and drink*'. Though they remarked that the nurse may have used this activity as a marketing exercise, they were fascinated by the guides' enthusiasm describing them as '*nice and dedicated*', carrying out their work '*with passion*' and explaining their job in a '*friendly and down to earth*' way.

Development of Cognitive Knowledge at the Greenhouses

Comparing the pre and post visit concept maps it was clear that after each visit, new concept and propositions were included, details were added to already existing concepts while unnecessary statements written in the pre-visit concept map were omitted and misconceptions were often cleared out. This indicated not only that learning had taken place but that the meaning of already existing concepts was extended. Concepts that were not new to the students were included and integrated showing that the visits helped students see links with previously learned knowledge that was previously considered unimportant.

Prior to the site-visit, the conditions needed by plants to grow, most commonly mentioned by the students were factors associated with photosynthesis. Joanna (Figure 2) included '*carbon dioxide*', '*light*' and '*water*' but showed difficulty in expressing concepts related to plants. Kevin (Figure 3) tried to add further detail related to plants from other modules including '*carnivorous plants*'. He added a lot of detail related to photosynthesis, influenced by the material being tackled in class at that time, including the raw materials needed, the products and their use by plants and mentioned the '*Calvin cycle*' indicating knowledge of the light independent reaction of photosynthesis. He further added details to concepts such as glucose '*stored as starch*' and '*diffusion of gases*'. Though most of these concepts were correct, they did not pertain to the focus question given.

After the visit, students realised that a greenhouse can offer ideal conditions for plants to grow. Joanna (Figure 4) explained that greenhouses offer plants '*protection from weather conditions like rain*', stated that greenhouses '*protect the plants from heavy rain, tough winds and high temperatures*'. In her concept map she included '*ventilation*', '*right nutrients*' and '*right temperature*' as further conditions plants need to grow. She distinguished between natural and artificial light which affect the flowering process and showed awareness of precautions the farmer needs to adopt to ensure suitable conditions for plants, including the issue of '*condensation*' which the farmer explained is harmful to plants and the issue of '*biological control*' which the farmer explained as preferring to chemical control which can induce pests to become resistant to pesticides. The idea of sentinel plants fascinated students who had never thought about this method of controlling pests.

ISSN 1648–3898

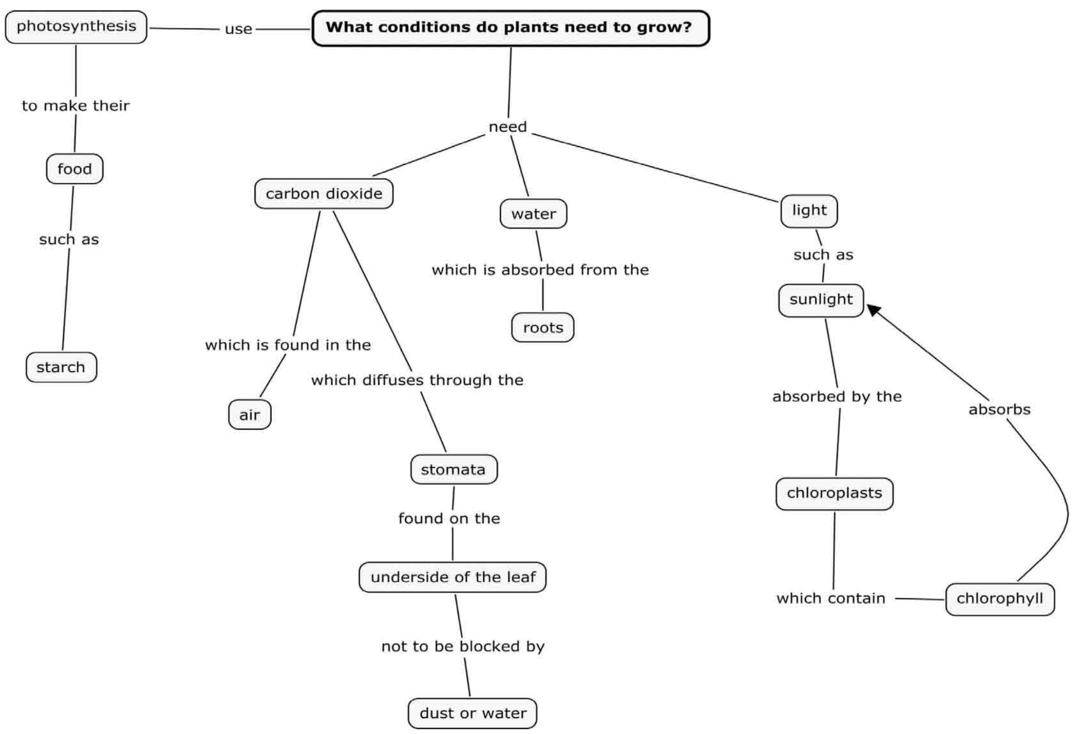

Figure 2: **Joanna's pre-visit concept map**

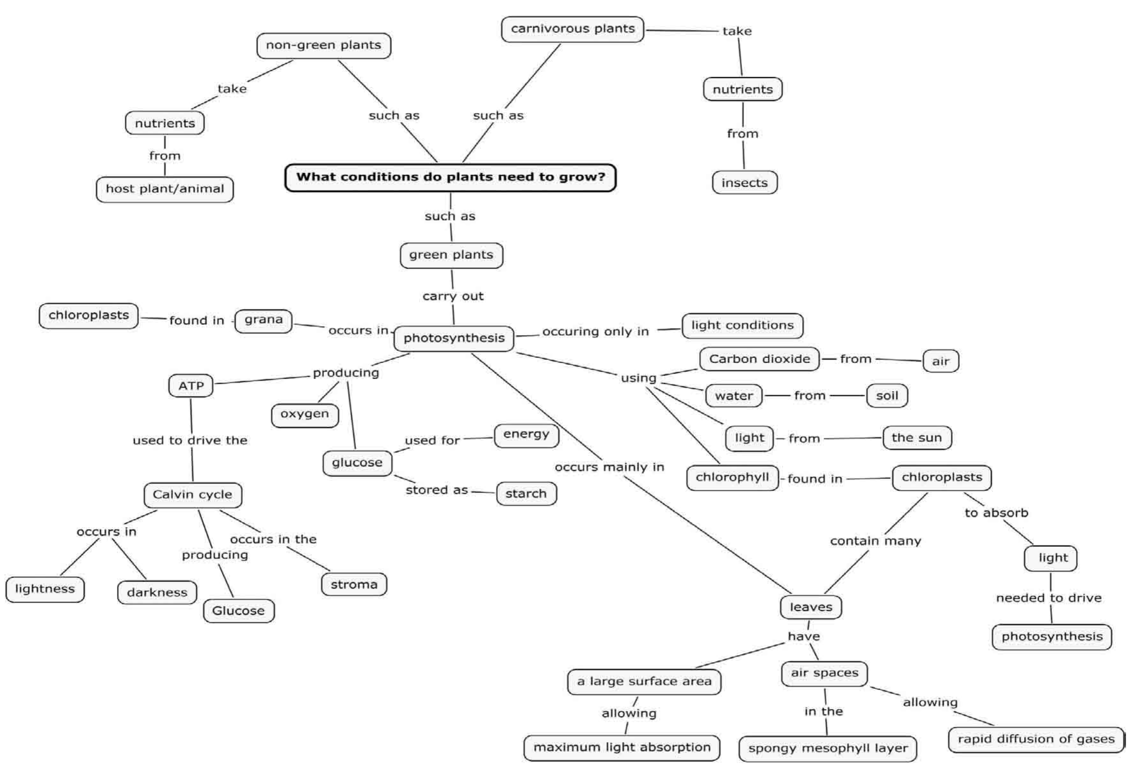

Figure 3: **Kevin's pre-visit concept map**

The majority of students showed awareness of the importance of a fertile soil, mentioning specific minerals needed by plants such as '*phosphates for roots*', '*potassium for the colour of flowers*' and '*nitrogen for young plants*'. Kevin (Figure 5) further introduced the issue of natural fertilisers '*such as green manure*' and '*artificial fertilisers*' whose disadvantage of lasting for '*one watering*' only was pointed out by the farmer. Kevin introduced the concept of '*warmth*' in his concept map showing awareness that a suitable temperature is needed by plants so that '*enzymes work faster*'. Kevin further developed the idea of light which can be natural or artificial and which is needed for different periods of time by different plants. The issue of water was extended to include how water is collected and supplied to the plants. Kevin observed '*drip irrigation*' during the visit which he had already heard about.

Development of Cognitive Knowledge at the Blood Bank

Students' pre-visit concept maps and the questionnaire filled in by the students as part of their coursework prior to the visit revealed that students had many knowledge gaps and curiosities about the premises and the blood donation procedure. The students thought that '*1 litre*' of blood is donated in '*beakers*', '*bottles*', '*plastic bags*', '*large bowls*', '*sterilised bags*', '*thick bags*' or '*test tubes*'. They were aware that persons who are *'sick'*, '*pregnant women*', *'people on antibiotics'*, '*people with HIV, haemophilia or anaemia*' or those '*who have recently done a tattoo*' could not donate blood while others were erroneously convinced that people who '*have tattoos*' or '*high cholesterol*' cannot donate blood either. Anna (Figure 6) and Joanna (Figure 7) were aware that blood is tested before given to patients but failed to give specific tests carried out and also failed to show the types of patients that would need the donated blood. None of the students showed awareness of blood components and how these are treated and used for different purposes. Neither did any student show awareness of the procedures taking place at the blood bank to ensure the safety of both the donors and the recipients of blood.

After the visit, the concepts presented by the students became more specific, the examples given increased and useless statements added before the visit were removed. Anna (Figure 8) added further detail about platelet donation which previously she '*did not imagine this could be done*', showed awareness that blood is separated into its components which have a different shelf life and need to be stored under different conditions. She gave specific examples of patients that need donated blood and raised the issue that suspicious blood is further tested and disposed of if not appropriate for the patients. Anna further added details to the '*blood bag*' which contains *'chemicals to prevent blood clotting'*. Joanna (Figure 9) further included details about the safety procedures the nurses in charge carry out to ensure blood is safe and hygienic, including '*bar codes*', the '*questionnaire*' with the donor's '*personal information*' which is '*kept for 10 years*' for further reference. Joanna showed particular interest in the information given by the guide and added details such as '*platelets donated by people over 17*' and different levels of haemoglobin in males and females and included the 4 specific tests that blood, collected in '*3 test tubes*' undergoes.

Further detail, not included in the concept maps was included in question 6 of the students' Vee diagrams, as shown by the underlined statements in figures 10 and 11. This question offered students the opportunity to express their new knowledge and information obtained on site more freely, without being restricted by a focus question. Through the students' responses, it was evident that each visit served as a unique experience for each individual student who was attracted to different issues tackled during the visit and different details observed on site.

ISSN 1648–3898

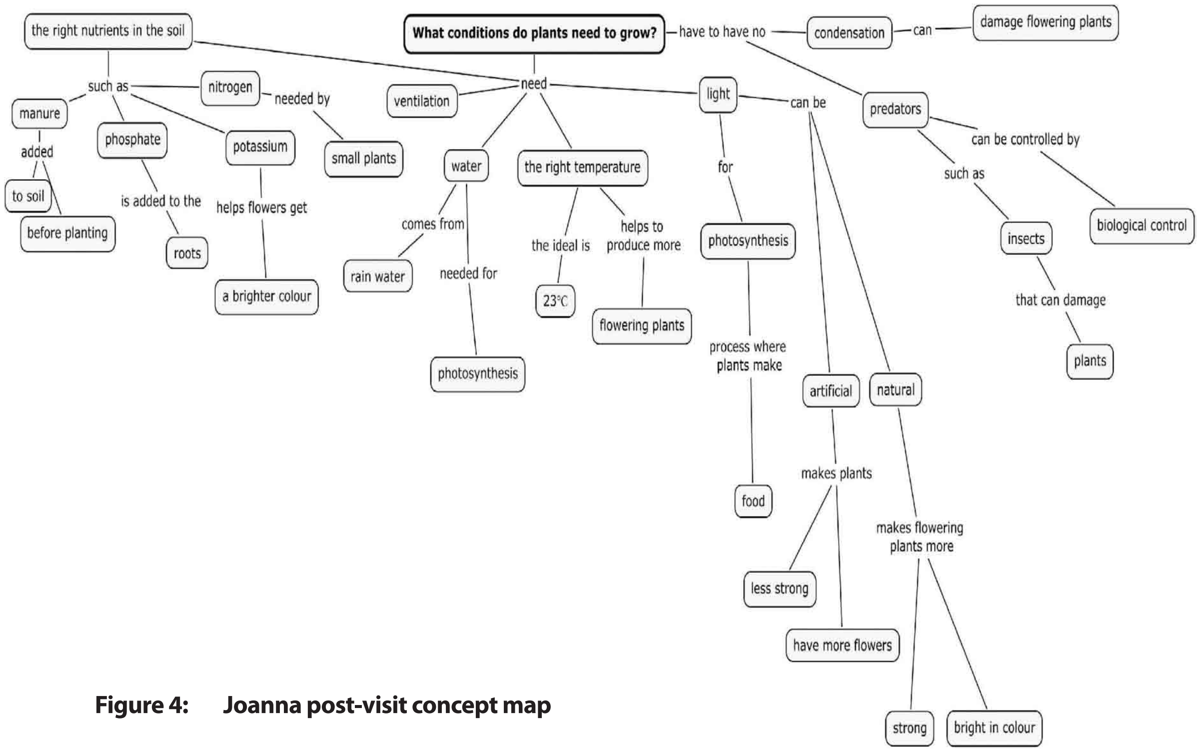

Figure 4: Joanna post-visit concept map

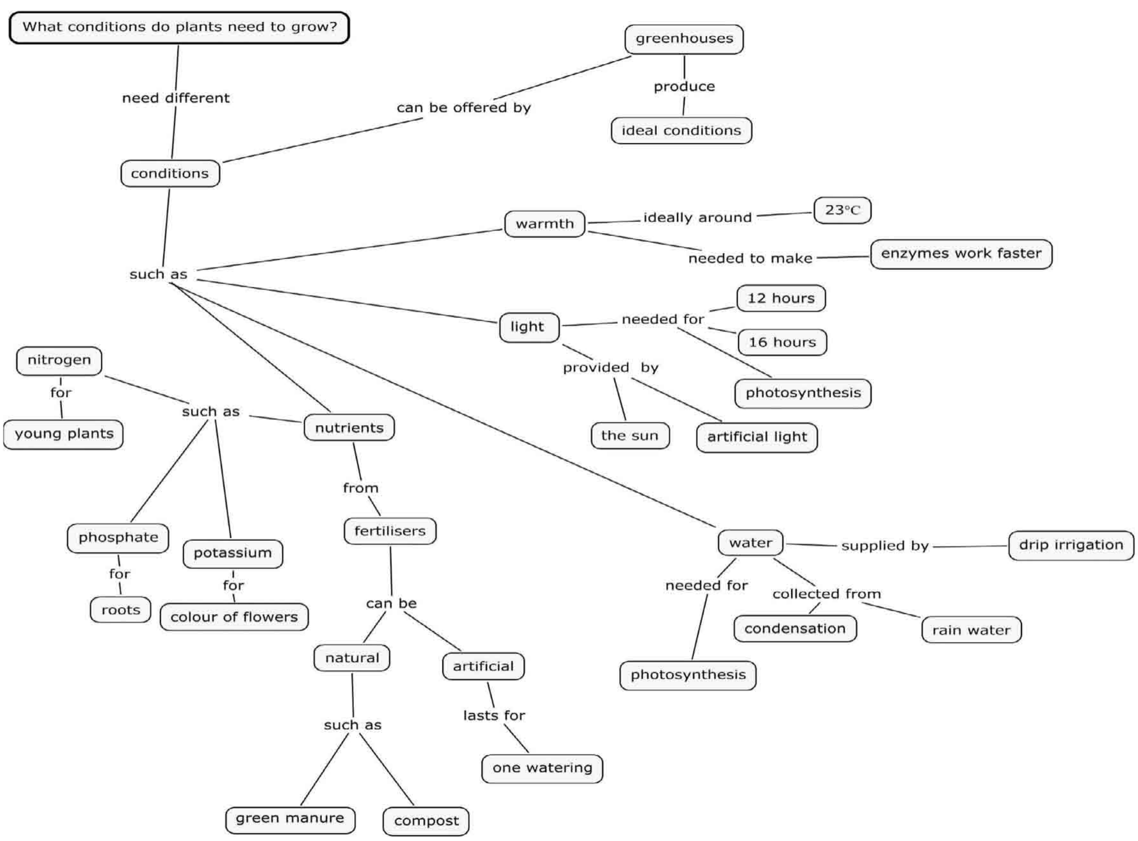

Figure 5: Kevin's post visit concept map

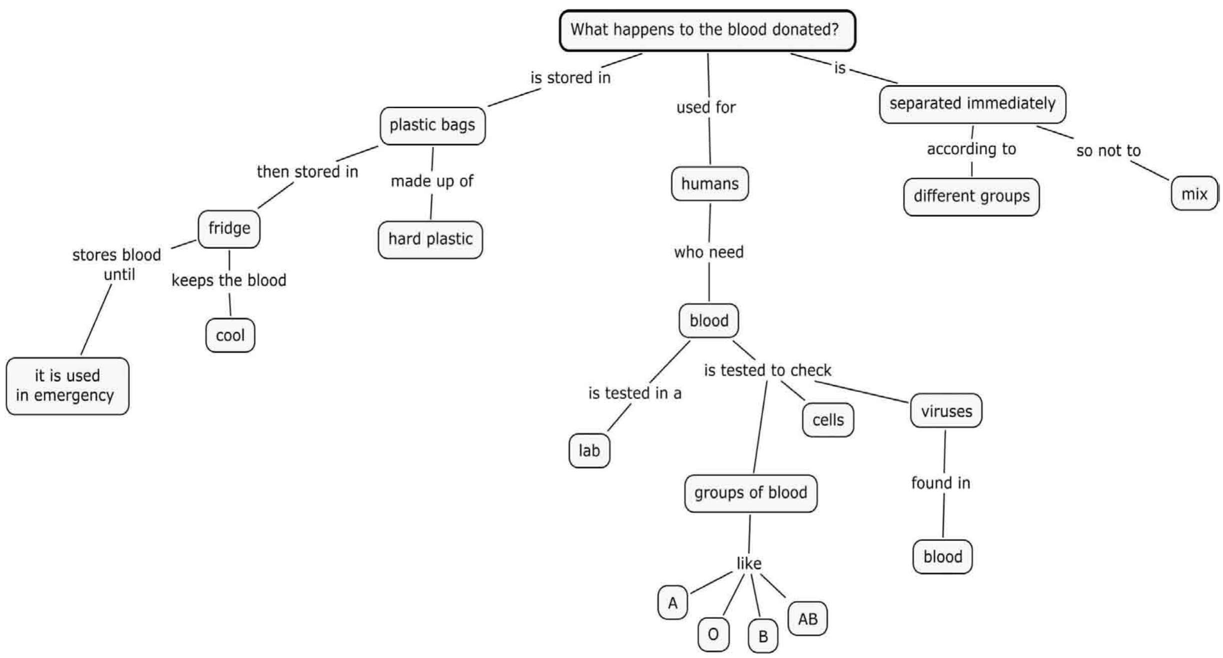

Figure 6: Anna's pre-visit

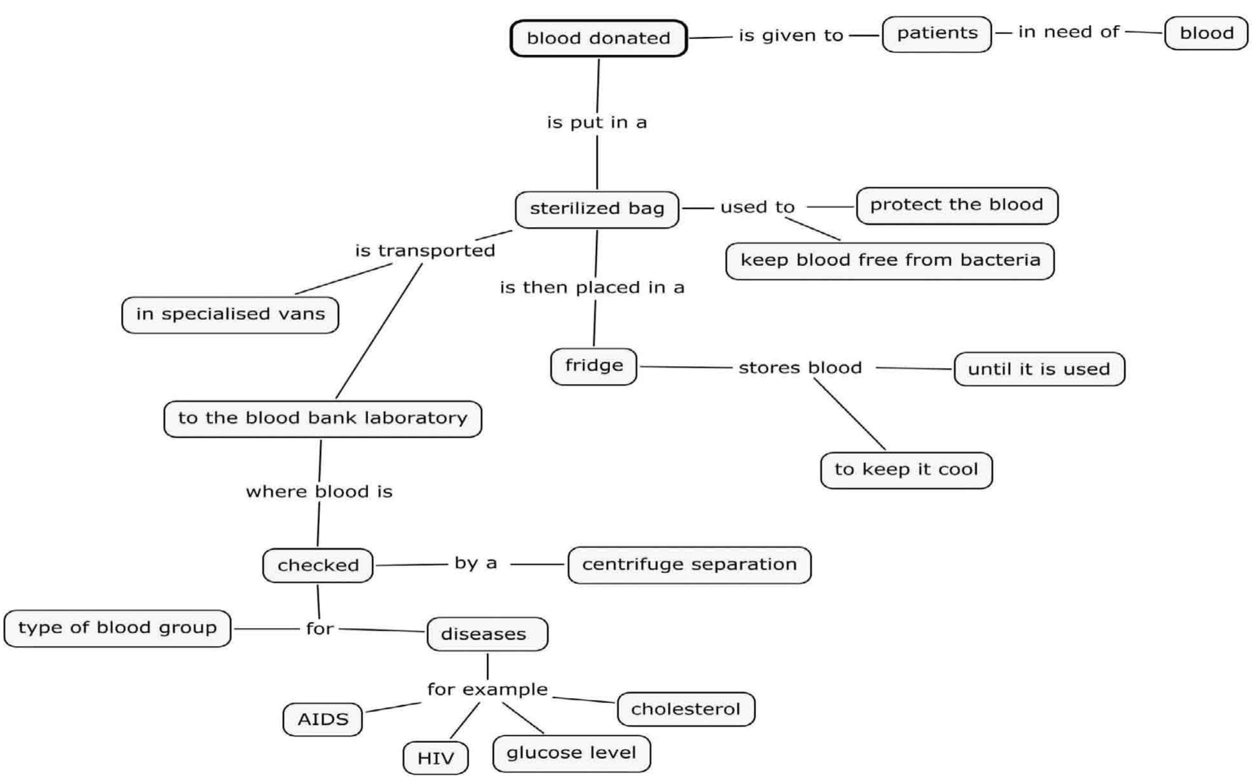

Figure 7 : Joanna's pre-visit concept map

ISSN 1648–3898

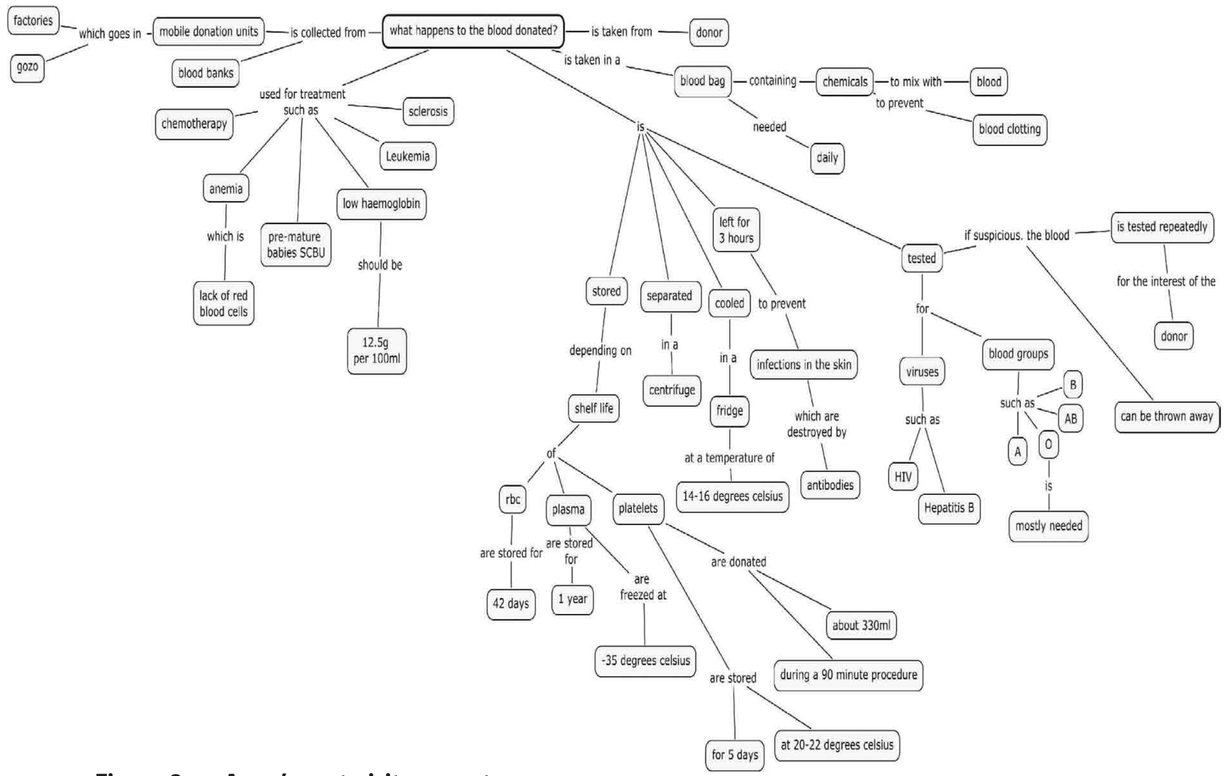

Figure 8: Anna's post-visit concept map

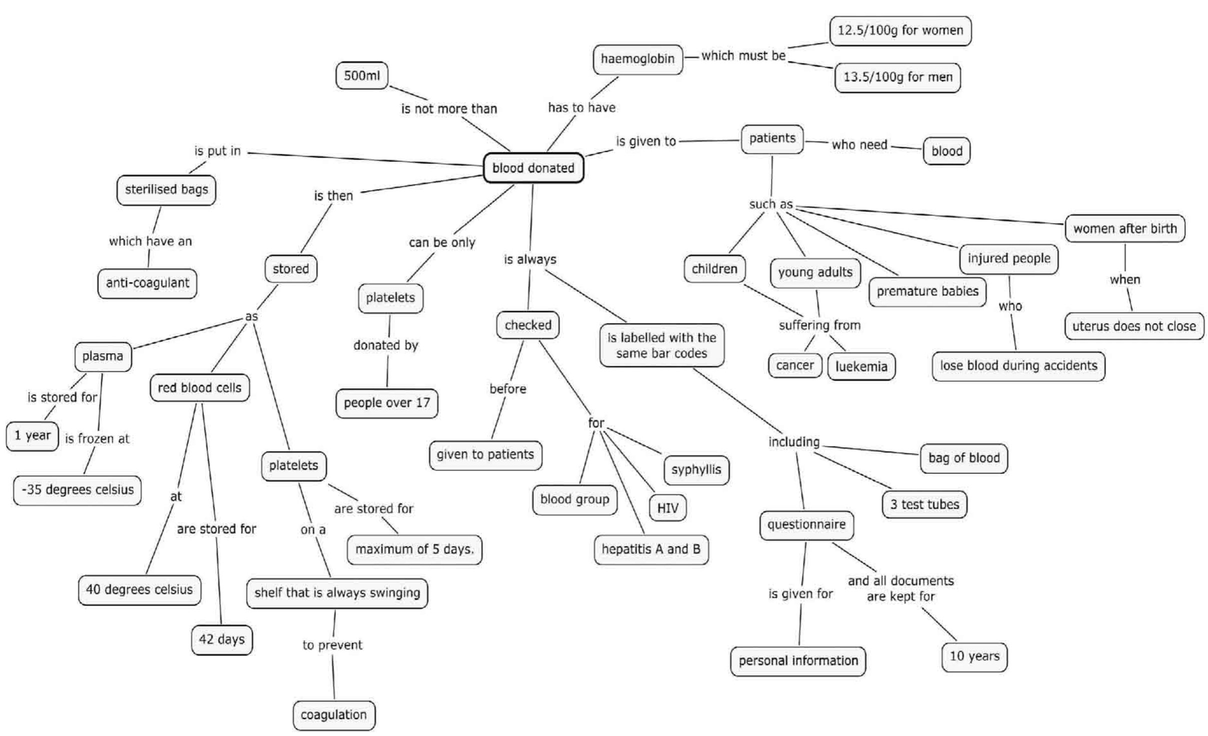

Figure 9: Joanna's post-visit concept map

Journal of Baltic Science Education, Vol. 12, No. 3, 2013
ISSN 1648–3898

What conditions do plants need to grow?

1. Why is this question important for you?

- plants is not my favourite topic. On the other hand it is interesting and part of my biology syllabus, therefore there is nothing that I can do.

2. In the space below, construct a concept map to show your knowledge about this question. (Figure 2)

3. How can you obtain more knowledge and information about this question?

- through internet
- notes
- conducting experiments
- watching pictures and DVDs.

4. Implementation

- visit to the greenhouses.

5. How did you obtain more information about this question?

- we went on a biology outing to a greenhouse.
- I read the biology notes.

6. What kind of information or new knowledge did you collect?

- natural light, unlike artificial light makes the flowers more strong and more bright, although artificial light helps the plant produce more flowers.
- the ideal temperature for flowers to grow is 23^0c.
- condensation harms the flowers therefore plastic is used so that the drops of water fall on the plastic and not on the flowers, so no damage to the plant takes place.
- crop rotation is used so more nutrients are added to the soil.
- biological control is used to capture insects.
- small plants are given a lot of nitrogen , phosphate is given to the roots and potassium is used when the plant starts flowering for their colour.
- manure is used before planting.
- extra plant matter is mixed with soil to get green manure.
- some plants need 16 hours of light.
- manual work is often carried out to prevent damage to the plants.

7. In the space below, construct a concept map to show your Knowledge about this question NOW. (Figure 4)

8. Why is this new knowledge important for you?

- as it is basic information not only on what conditions plants need

Figure 10: Joanna's Vee diagram for the visit to the greenhouses

Jonathan donates blood every 3 months. What happens to the blood donated?

1. Why is this question important for you?

- So that when I am able to give blood, I would want to know the process used.
- In my opinion, it is very interesting.

2. In the space below, construct a concept map to show your knowledge about this question:

(Figure 7)

3. How can you obtain more knowledge and information about this question?

- From the internet.
- Visiting the blood bank.
- Notes and videos

4. Implementation

- Show in class a short advert related to blood donation.
- Visit the blood bank.

5. How did you obtain more information about this question?

- We visited the blood bank
- I visited their website.

6. What kind of information or new knowledge did you collect?

- White blood cells are not donated to the patient.
- Donors must weigh 50 kilos or more.
- Blood is not tested for cholesterol, glucose level or high blood pressure.
- Some people can donate platelets only.
- Blood bags, test tubes and questionnaires are labelled with a bar code by the nurse in charge.
- Inside the bag there is an anti-coagulant.
- Plasma is used for people with burns.
- Plasma is fresh frozen in a big freezer which has ethanol at -40^oc for about 10 minutes, then is stored in a big freezer.
- The donor's documents are kept for 10 years.
- Gay people cannot donate blood.
- The bag and platelet kits are very expensive equipment

7. In the space below, construct a concept map to show your knowledge about this question NOW. (Figure 9)

8. Why is this new knowledge important for you?

- For my general knowledge
- So that when I go to donate blood, I will know what is happening and what

Figure 11: Joanna's Vee diagram for the visit to the blood bank

ISSN 1648–3898

Post-visit Class Discussions

Students commented that the blood bank visit was more informative and more personally relevant for them. They appreciated both site-visits as '*providing extra points and details which might come handy during the biology exam'* and for *'broadening knowledge'* so that when writing essays, they could '*definitely write more in depth*'. The visit to the greenhouses was appreciated by most students as a way of obtaining new knowledge that could be linked to *'topics related to the environment'* and to *'Environmental Science'* and '*English…because an experience like that will help you broaden your imagination*'. It served students '*to appreciate more the wonder and the functioning of nature*' and '*realise that growing plants is not as easy as most people imagine*'.

The post-visit class discussion revealed that each visit helped students learn new processes such as '*soil sterilisation*'. Allowing them to observe the practices taking place first hand and allowing them to hear from the farmer's direct experience helped them to consolidate agricultural issues which they '*had heard about before but never thought that farmers actually do them*', such as '*crop rotation*', using '*green manure*' and *'drip irrigation'*. The farmer's preference of biological control over chemical control was a point of discussion for the students. The use of sentinel plants in the greenhouse (used to detect pests before they attack the actual crop) were a source of awe and interest for the students and were described as '*plants that serve to protect other plants'* and as '*organic pesticides*. Walking inside the greenhouse led them to realise that *'it is really hot inside*' and allowed them to observe how the farmer provides the appropriate conditions for each type of plant and '*nurtures the plants…like a baby whom you have to take care of and give nutrients*'.

Observations made during the visit provided students with the confidence needed to actively engage in class discussion about the experience. For example, they expected the greenhouses to be *'made of glass'* rather than plastic because glass, although more expensive for the farmer, would constitute a *'one-time expense'* since it lasts longer and would need less maintenance. They explained that having bulbs in the greenhouse to control the amount of light at night means that the farmer has to pay for such conditions. Though these never featured in the concept maps, students mentioned specific names of flowers such as *'Gebra'* and *'Chrysanthemum'* when describing their observations.

Following the visit to the blood bank, the class discussion was characterised by the students' enthusiasm to discover so much new information about an issue that was so related to their personal life. They were surprised at the sophisticated and expensive equipment used on the premises and the accurate and meticulous procedures followed for example, how bags and test tubes are labelled with bar codes making the procedure as safe as possible. The fact that the donor undergoes a medical test, must weigh at least 50 kg and must fill in a questionnaire before s/he donates blood, which is kept confidential and stored for a number of years at the premises in case the donor needs to be traced was quite new to them. They discovered that blood is thoroughly tested in the interest of both the donor and the recipient and if tests were inconclusive, the blood was used for research.

Discussion

This research revealed that the classroom tends to be a restricted environment that limits the development of biological concepts. Biology teaching needs to be linked to learning infrastructures outside the school, which provide a network of influences; boosting student motivation to learn, knowledge acquisition and understanding, attitudes and beliefs (Dierking, 2005). As explained in Falk & Dierking's contextual model of learning (2000), students on a site visit were autonomous learners, free to choose what interested them most, were socially involved and in a more relaxed environment than the classroom. All these factors positively influence learning. Students had the opportunity to roam about, be creative, satisfy their curiosities and become actively engaged in the activity by contributing their insights - an attitude conducive to higher levels of learning.

The methodology used moved away from the transmission model of learning and induced students to shift from rote memorisation of biological vocabulary and definitions, to more meaningful learning, integrating new concepts into pre-existing structures, while experiencing the desire to learn, discover, question their surrounding and think critically. Rather than filling in worksheets and taking notes - an approach criticized by Griffin & Symington (1997) for killing the students' enthusiasm to explore new environments - students became more autonomous and focused on observing their surroundings. This approach, unlike traditional learning methods did not aim at rewarding students proficient in memorising scientific words and definitions but probed into their understanding and application of knowledge to everyday life. As argued by Mintzes, Wandersee & Novak (1997), throughout the whole procedure, learning became the responsibility of the learners and their conscious decision to learn meaningfully. Meanwhile the teacher had the parallel responsibility to provide students with the opportunity to learn and help them construct meaning and evaluate their understanding, thus acting as a facilitator rather than a knowledge provider.

Enthusiasm during post-visit discussion was a positive consequence of the visits, yet it evidenced the lack of class time where students are given the opportunity to talk, discuss and express themselves. Throughout these activities students had the opportunity to voice their opinions without being assessed for the exam, thus giving the students 'the opportunity of a cumulative development of understanding and interest' (Rocard, Csermely, Jorde, Lenzen, Walberg-Henriksson & Hemmo, 2007, p.8), in an educational system which seems to deem their points of view as irrelevant and valuing only a restricted area of knowledge, which is arid and useless unless the students link it to their personal life experiences.

Learning does not begin and end on site and the visit becomes part of a continuum of learning experiences. Infact throughout the study, students assimilated each experience within a larger framework, including past experiences and future aspirations, made connections between the reality they observed and their background knowledge and personal life experiences. They linked new knowledge to other subjects studied at school and explained that each visit made sense as it complimented the material being covered in class. This in turn made them familiar with the topics' technical vocabulary and prepared them to observe the real life aspect of the issues tackled on site. Learning is context-specific and it is easier for the students to make learning more meaningful when inert knowledge - learnt in a decontexualised classroom environment - is transferred to a more relevant physical context (Falk & Dierking, 2000). This increases 'the likelihood of long-term retention of the subject matter' (Knapp, 2000, p. 72).

Conclusion

Site-visits offer students a vast repertoire of learning opportunities, where they learn biological knowledge, improve their social skills and develop a more positive attitude towards biology, motivating them to carry out further research and share their knowledge with family and friends. Out-of-classroom activities adopted an experiential and holistic learning approach where students observed and discussed biological issues within the context of their relevance to their daily lives rather than as stand-alone topics. In a contextualised environment, students could easily bridge the gap between inert knowledge given in class to the real world. Careful planning of each site-visit ensured that the experience was not interpreted by students as a one-off fun activity, but as a learning experience that connects to, extends and reinforces classroom practice. Students linked this information to different subjects learned at school contributing to less compartmentalisation and more meaningful learning. The uniqueness of out-of-classroom learning environments lies in their offering direct experience with concrete phenomena and processes which cannot be cultivated in the classroom, thus catering for a diversity of learning patterns and offering students different ways of learning. Site-visits contributed to the production of more scientifically literate students capable not only to reproduce biological vocabulary in an exam, but to critically understand issues, reflect upon them and discuss scientific issues. This was observed in all the students in class, not just in the science-oriented student minority. Such conclusions might indicate that by linking theoretical knowledge to real-life experiences, site-visits could provide other academic subjects with opportunities to actively engage students in their learning.

The methodology used throughout the study i.e. a learner-centred strategy, moved away from the traditional task-oriented activities such as note-taking or filling in worksheets. Students were allowed to explore their surroundings, in the sequence they liked and focus on issues that interested them most,

ISSN 1648–3898

without being restricted by learning targets pre-planned before the visit. Students were free to reflect and assess their own knowledge, misconceptions or empty gaps. The visits prompted students to question and link their pre-existing concepts to new knowledge, making learning more meaningful, whilst providing their teacher with an opportunity to know the students and tailor each activity according to their respective needs. Most of the benefits of site-visits are dependent on the contexts within which teachers function. This particular research was conducted in a setting where although such visits were not part of the prescribed teaching programme, the teacher had sufficient freedom to adopt this out-of-school approach. Teachers who lack this physical and curricular freedom would face difficulties in adopting site-visits – provided that they are not specifically requested by the teaching programme.

This study was limited to a one year study with a small group of students. Further research in this area could involve following the same group of students and interview them about their experience to explore the impact of site-visits over time. Moreover, further research with different groups of students could focus on different student characteristics, in terms of age, gender and subject majors, in relation to learning on site.

The conclusions drawn from this study suggest that site-visits, complementing classroom practice should serve as a useful tool for teachers to help students develop an authentic picture of biology. Giving them an opportunity to observe biology in real world situations contributes to boost their interest in the subject, identify its relevance to their life, understand its concepts, increase their knowledge thus making it more meaningful and easier to remember.

References

Åhlberg, M., & Ahoranta, V. (2002). Two improved educational theory based tools to monitor and promote quality of geographical education and learning. *International Research in Geographical and Environmental Education*, *11* (2), 119-137.

Borun, M., & Dritsas, J. (1997). Developing family-friendly exhibits. *Curator*, *40* (3), 178-196.

Braund, M., & Reiss, M. (2006a). Validity and worth in the science curriculum: learning school science outside the laboratory. *Curriculum Journal*, *17* (3), 213 – 228.

Braund, M., & Reiss, M. (2006b). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International Journal of Science Education*, *28* (12), 1373- 1388.

Csikszentmihalyi, M., & Hermanson, K. (1995). Intrinsic motivation in museums: Why does one want to learn? In Falk, J. K. and Dierking, L. D. (Eds.) *Public institutions for personal learning: Establishing a research agenda*. Washington, DC: American Association of Museums.

Dewey, J. (1938). *Experience and Education*. New York, NY: Collier.

Dierking, L. D. (2005). Lessons without limit: how free-choice learning is transforming science and technology education. *História, Ciências, Saúde – Manguinhos*, *12* (supplement), 145-160.

Dillon, J. (2006). Education! Education! *Primary Science Review*, *91*, 4-6.

Falk, J. H. (2004). The director's cut: towards an improved understanding of learning from museums. *Science Education*, 88 (Suppl. 1) 83-96.

Falk, J. H., Coulson, D., & Moussouri, T. (1998). The effect of visitors' agendas on museum learning. *Curator*, *41* (2), 106-120.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: AltaMira Press.

Falk, J. H., & Dierking, L. D. (2002). Learning *without limits: How free-choice learning is transforming education*. Walnut Creek, CA: AltaMira Press.

Falk, J. H., & Dierking, L. D. (2004). The contextual model of learning. In G. Anderson (Eds.*) Reinventing the museum. Historical and contemporary perspectives on the paradigm shift.* Walnut Creek, CA. Altamira Press.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Basic Books.

Gerber, B. L., Cavallo, A. M. L., & Marek, E. A. (2001). Relationships among informal learning environments, teaching procedures and scientific reasoning ability. *International Journal of Science Education*, *23* (5), 535-549.

Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning-oriented strategies on school excursions to museums. *Science Education, 81*, 763-779

Knapp, D. (2000). Memorable experiences of a science fieldtrip. *School Science and Mathematics, 100* (2), 65 – 72.

Krapp, A. (2002). Structural and dynamic aspects of interest development: theoretical considerations from an ontogenetic perspective. *Learning and Instruction*, *12* (4), 383-409.

May, S., Richardson, P., & Banks, V. (1993). *Fieldwork in action: Planning fieldwork*. Sheffield: Geographical Society.

Millar, R., & Osborne, J. (Eds.) (1998). *Beyond 2000: Science education for the future*. Retrieved March 10, 2010 from

King's College, School of Education. Website: http://www.kcl.ac.uk/content/1/c6/01/32/03/b2000.pdf
Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (1997). Meaningful learning in science: The human constructivist perspective. In G. D. Phye (Ed.), *Handbook of Academic Learning: Construction of Knowledge*. San Diego: Academic Press.
Oppenheimer, F. (1986). *Working prototypes: Exhibit Design at the Exploratorium*. San Francisco: Exploratorium Publications.
Orion, N. (1993). A practical model for the development and implementation of field trips, as an integral part of the science curriculum. *School, Science and Mathematics*, *93* (6), 325-331.
Parvin, J., & Stephenson, M. (2004). Learning science at industrial sites. In M. Braund & M. Reiss (Eds.) *Learning Science Outside the Classroom*. London: Routledge Falmer.
Rennie, L. J., Feher, E., Dierking, L. D., & Falk J. H. (2003). Towards an agenda for advancing research on science learning in out-of-school settings. *Journal of Research in Science Education*, *40* (2), 112-120.
Rocard, M., Csermely, P., Jorde, D., Lenzen, D., Walberg-Henriksson, H., & Hemmo, V. (2007). *Science education now: A renewed pedagogy for the future of Europe*. Retrieved January 5, 2010 from the European Commission, Directorate-General for Research. Website:
http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf
Shortland, M. (1987). No business like show business. *Nature*, *328*, 213-214.
Uitto, A., Juuti, K., Lavonen, J., & Meisalo, V. (2006). Students' interest in biology and their out-of-school experiences. *Journal of Biological Education*, *40* (3), 124- 129.
Woerner, J. J. (1999). *Virtual Field Trips in the Earth Science Classroom*. Retrieved August, 2009 from
http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/16/9c/e2.pdf
Woolnough, B. E. (1998). Authentic science in schools, to develop personal knowledge. In J. Wellington (Ed.) *Practical work in school science. Which way now*? London: Routledge.

Received: *March 12, 2013*　　　Accepted: *May 06, 2013*

Miriam Muscat	B.Ed. (Hons), M.Ed., LLCM, Head of Department for Integrated Science, University of Malta, Malta.
Paul Pace	PhD., Professor, Deputy Dean, Faculty of Education, Director, CEER (Centre for Environmental Education & Research), Room 327 - Faculty of Education, University of Malta, Msida MSD 2080 – Malta. E-mail: paul.j.pace@um.edu.mt Website: http://www.um.edu.mt/ceer