The use of mind maps as an assessment tool.

Robbie O'Connor
robbie.oconnor@ittdublin.ie
Department of Mechanical Engineering
Institute of Technology Tallaght
Dublin, Ireland

Abstract

Mind maps are a well established study aid tool. For visual learners they provide a very useful technique to represent a complex topic in a form that will help a student remember details that would otherwise be difficult to represent in text.

The school of Engineering in IT Tallaght have recently developed a course in Energy and Environmental Engineering. The course introduces modules into the first semester that give the student a general context for the detailed technical content covered in the rest of the course.

Given the increasingly diverse nature of our students' academic background, age profile and learning styles, we have had a difficulty assessing the student's understanding of these modules without resorting to essay type exam questions or assessments..

A number of assessment techniques were employed including online testing of specific details of each topic and the assessment of a mind map completed by each student on that topic. The aim was to test the students ability to recall the salient details and then to assess the students understanding of how the different elements relate to each other.

This paper deals with the experience gained through the assessment of over 1500 mind maps over a three year period. The paper outlines an assessment rubric that has been developed over this period and deals with the experiences gained.

Keywords

Mind maps, assessment, Rubric, Global / Visual thinkers.

1. Introduction and Motivation.

The School of Engineering at IT Tallaght has a long tradition of developing and delivering courses that suit both full time students and mature industry based students. One of these courses is the B.Eng. in Energy and Environmental Engineering. This course has proven to be a very popular among both CAO applicants and mature students. Our first students are due to graduate from the course in 2012. Approximately 50% of which are mature students attending in part time mode.

The course was designed to include general modules in the first year that would give the student the context for the technical modules that are a necessity in all engineering course. One of these modules was entitled "Global Environment". The aim of this module was to give the student a context for the emphasis on energy efficiency, waste minimisation and clean technologies that the student would have to address in the latter modules in the course. While devising an assessment strategy for the module, there was some concern that some students might struggle to perform well if the learning outcomes were assessed using traditional essay type assignments. This concern was subsequently reinforced through learning style assessments that confirmed a strong bias towards visual learning in the group.

With this in mind it was decided to assess the learner's recall and technical ability using online quizzes. Following this, the learner's grasp of the relationship and significance of the material is then assessed through the completion of a mind map by the student for each topic.

2. Mind maps.

Mind maps can be described as a graphical method of representing a topic. The visual structure helps the user represent concepts and ideas with images, colours and symbols if they so wish. A typical mind map might have a central idea and a hierarchical or tree branch format, with ideas branching into their subsections. Although, in practice, there is no compulsory structure.

Most engineering students would be familiar with structure diagrams such as concept maps, fault tree diagrams, logic diagrams etc. A key distinction between mind maps and other types of diagrams is that there is no established right or wrong way to complete a mind map. For example a concept map would usually take the form of a top down diagram where each level has an expanded lower level in its hierarchy. This can be appropriate for technical concepts but can be restrictive for other general topics.

One disadvantage of the use of concept maps is that they might result in students over simplifying areas in order that they fit that structure. Mind maps on the other hand are more flexible and can take any structure. For this application the use of mind maps was considered more appropriate as they are flexible enough that the student could represent the topic without the constraints of other types of maps.

The key strength of mind maps is that they allow the learner flexibility to associate different concepts using colour, shapes or images without constraining the learner to a fixed format or structure. Unfortunately, this also can make them difficult to assess.

3. The assessment of mind maps.

While considering the use of mind maps as a gradable piece of student work, a rubric for assessment had to be developed. The Rubric:

- Should be appropriate to the required learning outcome for that topic. In this case the level assessed was at the "describe" end of the spectrum rather than the "evaluate" end.
- Should be fair to all the different types of learners in the group.
- Would not hinder the mature students whose computer literacy may not be as high as the younger students.
- Would not give unfair advantage to aesthetic layout over technical detail.
- Should not hinder flexibility

The rubric was also formulated in a domain independent way in order that it would be suitable for use in a range of disciplines.

Some ground rules had to be established with the students as to how the mind maps would be assessed. The first of which was that the student could use any method to generate the map so long as they could upload the final version to our elearning platform. All our students have access to free scanning facilities. The second was that the content and structure would take precedent over appearance.

A range of sample mind maps were made available to the students with indicative marks allocated to each to illustrate the marking scheme in practice. Once the students had submitted their first attempt, this was graded and feedback was given to each student.

The main characteristics that have been used to assess the mind maps are listed below.

Comprehensiveness,

Broadness of Knowledge:

This can be as simple as an element count. For a topic such as water pollution, the material is easily divided into main sections and it would be reasonable to expect an element in the mind map to represent each element.

Focus, wrong focus, emphasis on wrong areas,

Although students may have grasped the elements that make up a topic they may have misinterpreted the overall thrust of a topic and represent this by having a mind map with the wrong focus or with emphasis giving the wrong priority to certain elements.

Organisation and layout.

Branches well defined and placed,

In certain instances a student may not have a detailed understanding of a topic but may have a general grasp of the overall topic and can represent this in a well defined and placed branch structure.

Structure, Sophistication of branch structure, use of links,

The use of links between elements and sub elements of a mind map will demonstrate the student's appreciation of the complexity and interrelationships that exist between the topics.

Sophistication, Correct integration of concepts in an organised complete structure.

It is very apparent where a student has a full understanding of a topic and relationship between each element and sub element in a mind map.

Correctness,

Accuracy of information,

It is usually quite obvious where the learner has included mistakes or incorrect elements. In conjunction with this it is relatively easy to interpret any misconceptions /errors in understanding that the student has at this stage.

These characteristics have been condensed in to a grading rubric that is made available to the students. Although in practice, I have found that the students far prefer the visual examples of graded mind maps rather than the rubric.

The rubric used was:

	Excellent	*Very Good*	*Good*	*Poor*
Comprehensiveness:	The map completely defines the subject area. All topics and sub topics are represented in the mind map.	The map is complete but missing one or two less significant elements.	The map has adequate representation of each topic and sub topic to demonstrate a basic understanding of the topic.	There are significant elements that are missing from the mind map.
Organisation and Layout	The map is well organised with element integration and topics linked where appropriate. Feedback loops are also used where appropriate. The branch structure is sophisticated.	The map has adequate organisation with some branch and elements connections. Although there might be links between elements some are missing.	The map is organised with a limited number of branches and elements.	The map is arranged with the minimum number of elements. These are arranged only or predominantly in one in one form, e.g. linearly.
Correctness:	The map integrates elements correctly and reflects an accurate understanding of the subject matter with no misconceptions.	The map has few subject matter inaccuracies. Most links are correct.	The map has some subject matter inaccuracies but these are not fundamental.	The map is naive and contains misconceptions about the topic area. Inappropriate terms are used

3. Sample mind maps.

In order to aid comparison the following mind maps have the same subject matter.

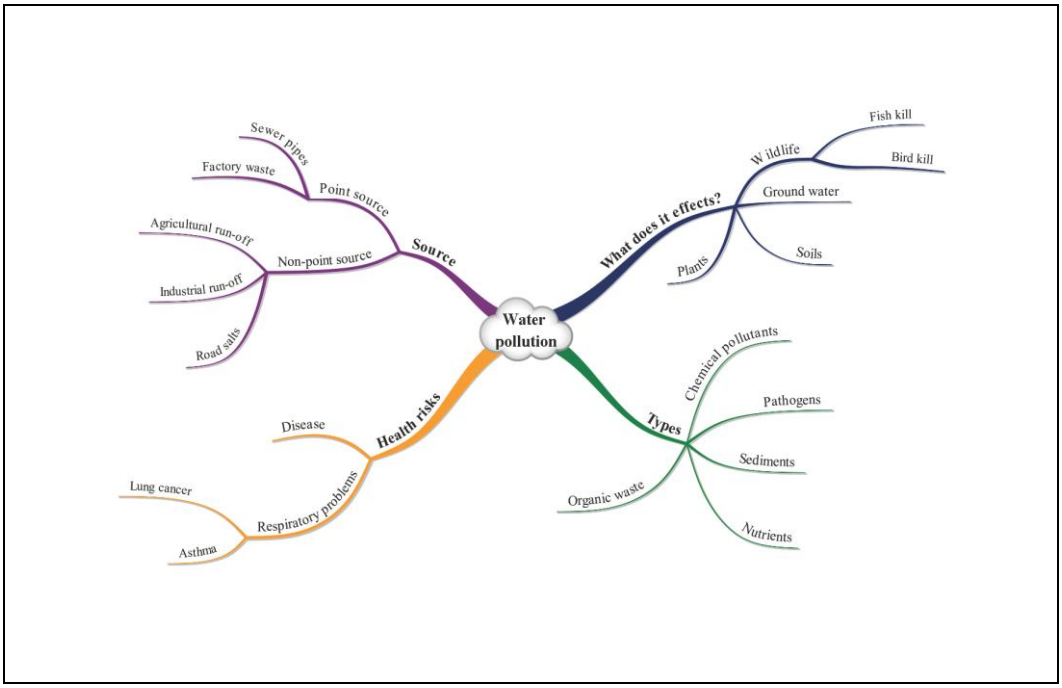

Figure 1. Good mind map.

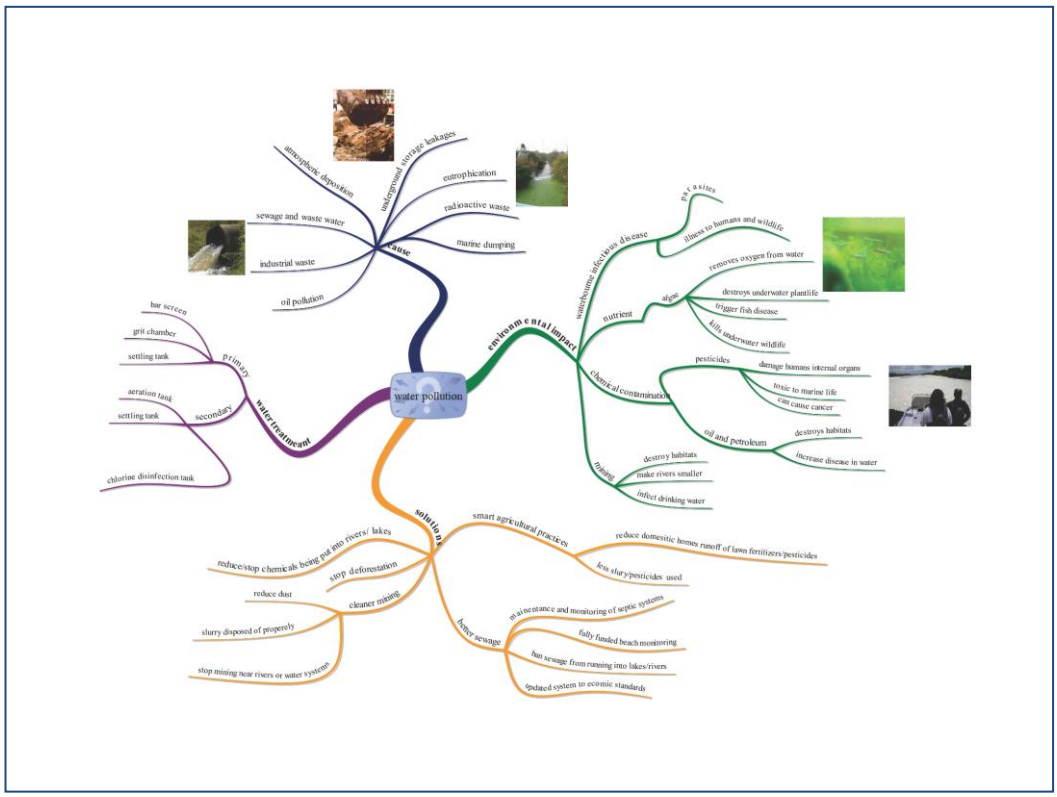

Figure 2. Very good mind map

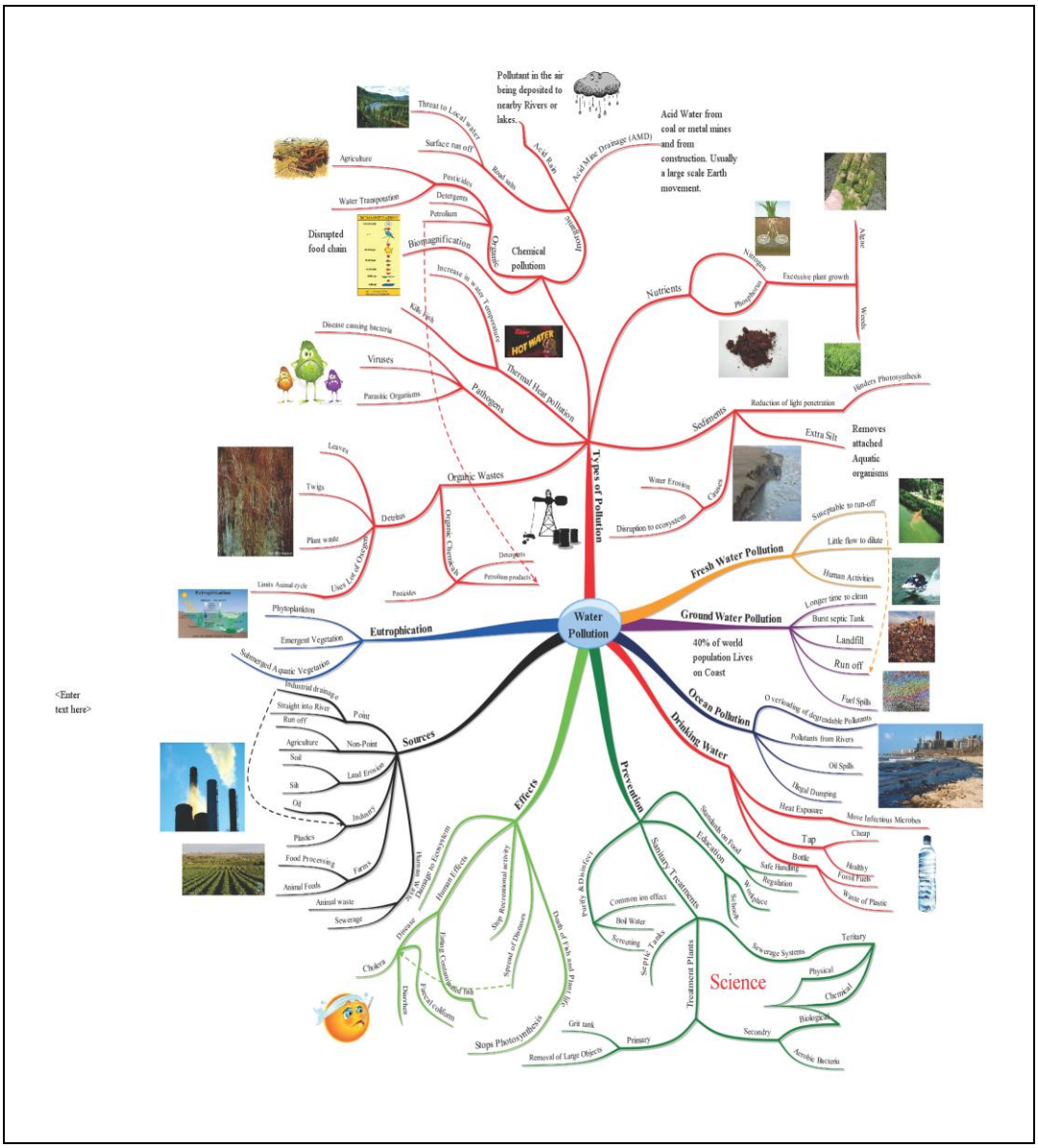

Figure 3. Excellent mind map

These mind maps show the progression from a good to an excellent mind map.

The first mind map, figure 1, consists of the main elements and sub elements for the overall topic. The student has arranged the elements in a logical way and arranged the sub-elements in an appropriate way. There are some minor spelling mistakes.

In the second mind map, figure 2, the student has divided the topic into more detailed elements and has sub divided these into sub elements. The mind map is comprehensive and the student has clearly thought about what categories to use and how to arrange them in the mind map.

The third mind map, figure 3, is both more detailed than the previous and the student has linked the elements to demonstrate their appreciation for the relationships between the elements.

In the following mind map, figure 4, the student included every element that was covered in the lecture notes and in the lecture. The student clearly has a flair for design and layout. This mind map would be exceptional.

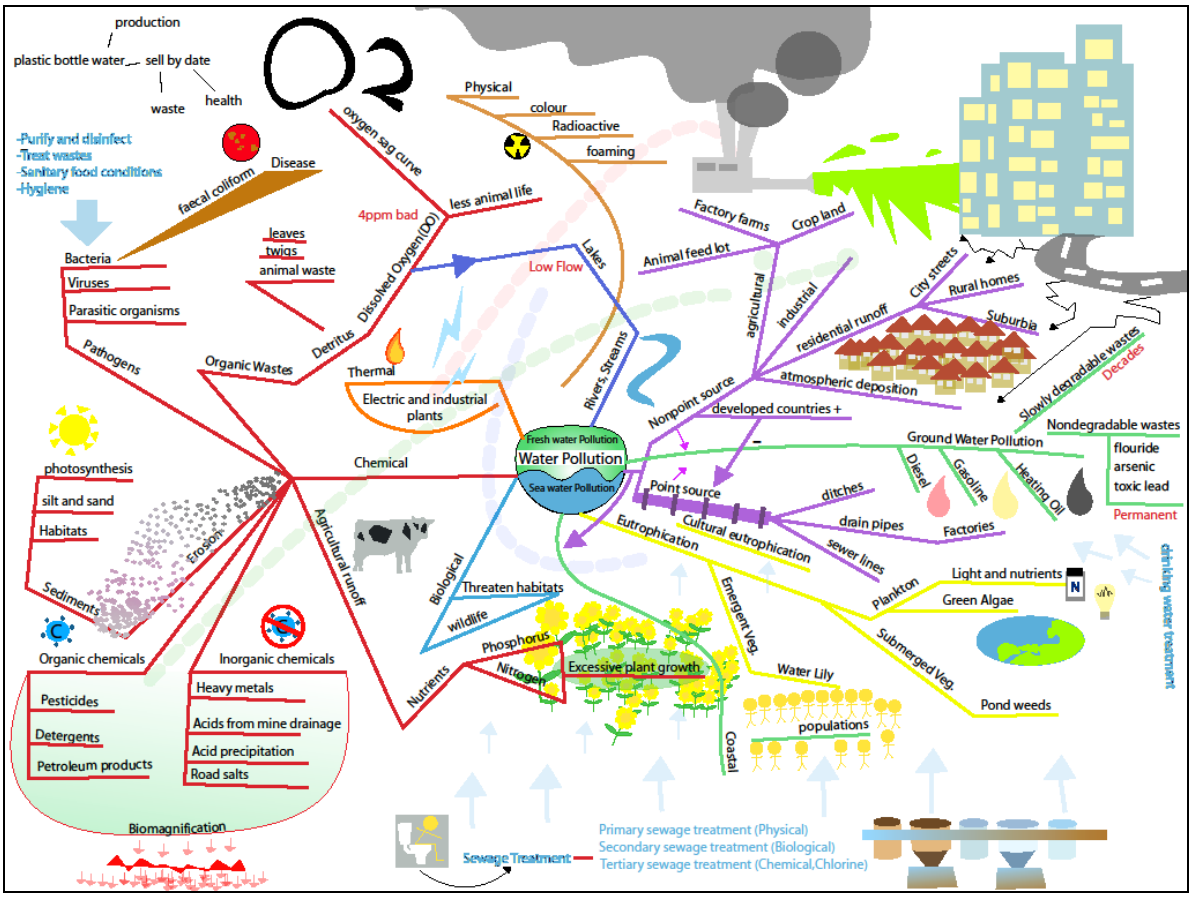

Figure 4.

The following mind maps are show examples where the students have chosen to either hand draw to use standard office type software.

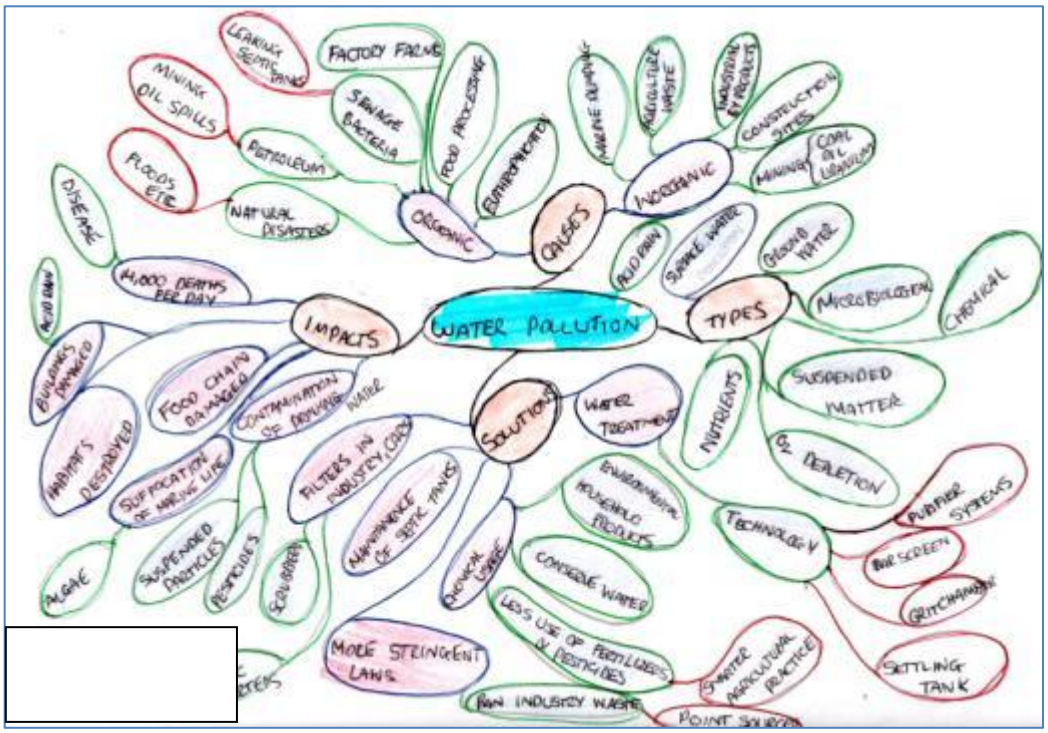

Figure 5. Hand drawn.

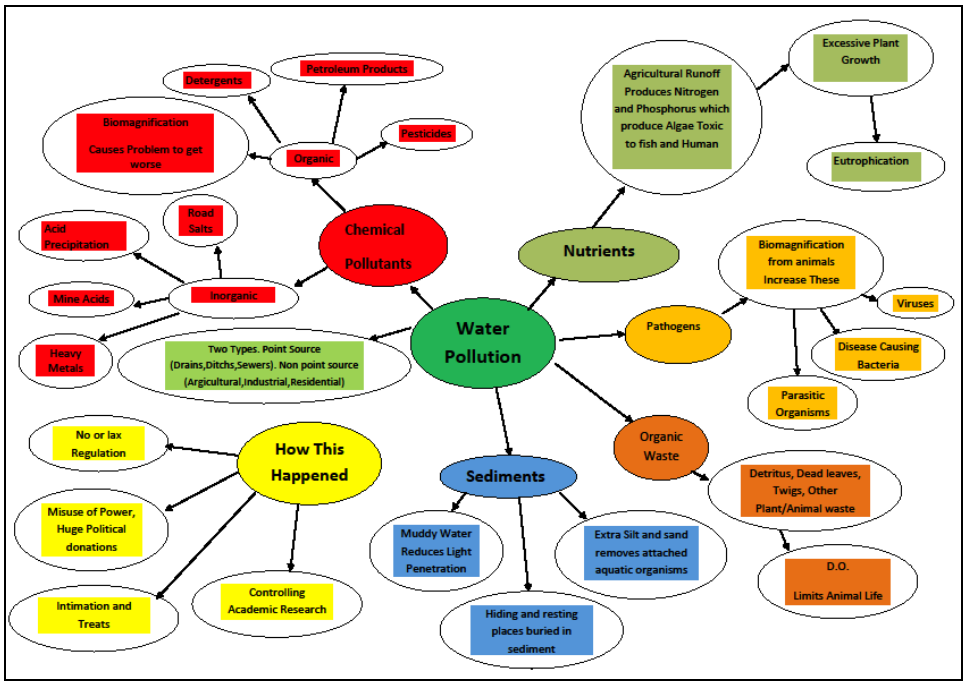

Figure 6. Microsoft Word.

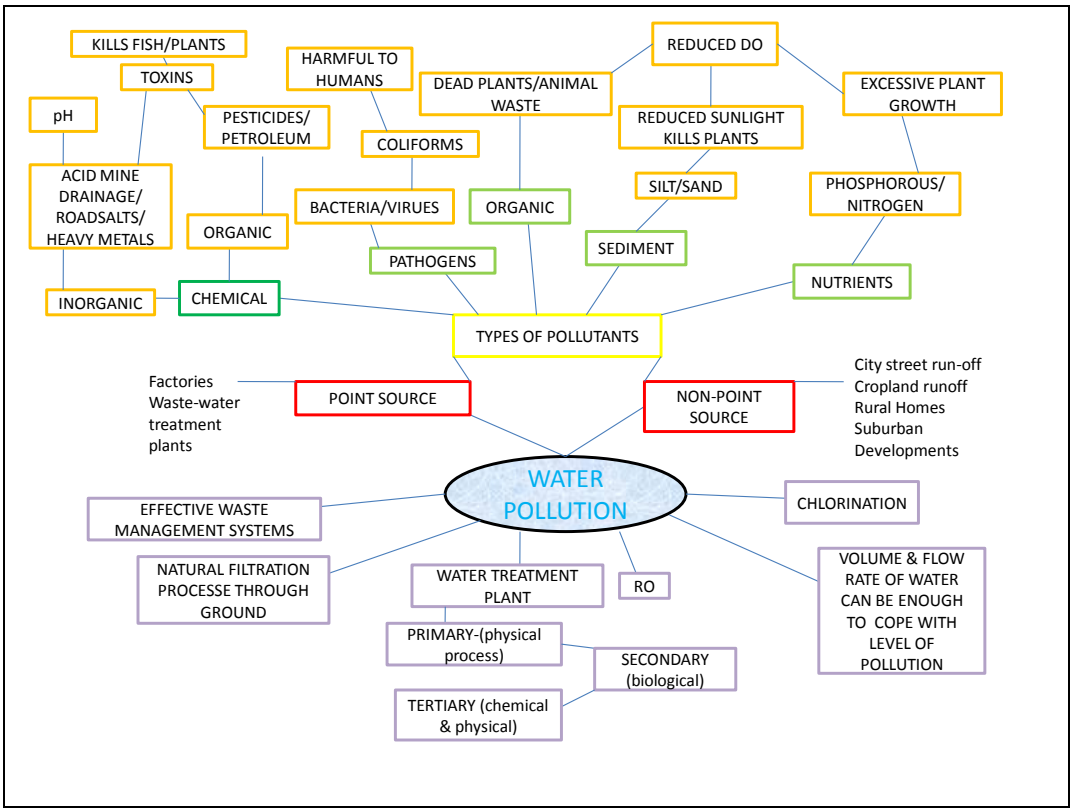

Figure 6. Microsoft PowerPoint.

4. Conclusions and Future Work.

Feedback from students, both formal and informal, would indicate that they enjoy using mind maps. From the outset they find them quite challenging but then become quite enthusiastic about them. A positive development has been that a significant number have chosen to use mind map structures for poster presentations in subsequent modules in the course.

The students quickly appreciate that the production of a good mind map requires that they think about the subject rather than regurgitate details.

The better students excel at them and the mature students, in particular, seem to enjoy the opportunity to demonstrate their level of understanding of a topic through their mind maps. In fact, I have to be quite clear to the students about what I would consider the maximum time that they should spend on any one mind map!

Care must be taken to ensure that the use of a mind map to assess is appropriate to the specific learning outcome. In this case the mind maps are used to assess learning outcomes that fall into the "describe and outline" category rather than the higher level outcomes. Another concern is that a mind map may be difficult to complete without appearing ambiguous. In these cases it might be a reasonable option to allow the student to supplement their work with a paragraph outlining where they had difficulty representing a concept.

I am at an advanced stage in the development of an interactive mind map for the entire module. This would be the primary interface for the students and would give them access to a hierarchy of mind maps eventually leading them to detailed topic notes. The aim is that the students will start with a visual representation of the module and have to drill down through mind maps to get access to the detail notes rather than the opposite.

5. References

Besterfield-Sacre, M.,(2004). Scoring Concept Maps: An Integrated Rubric for Assessing Engineering Education, National Science Foundation: Engineering Education: Assessment Methodologies and Curricula Innovations (EEC-9872498)

Thanks to the students of the B.Eng. in Energy and Environment who have agreed to let me use their mind maps in this paper.