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CONSTRUCTIVISM IN CURRICULUM DEVELOPMENT - A CASE STUDY AT THE SINGAPORE MARITIME ACADEMY

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ABSTRACT

The behavioural practice of deciding in advance the scope of knowledge and skills to be imparted to students in a subject curriculum is a norm at the Singapore Maritime Academy. On the other hand, in a frequently frowned-upon constructivist approach, the process of curriculum development needs to be initiated by considering the knowledge and experiences the student brings with him. The new content should then be built around this so that the connections between the old and the new knowledge are well established.

Recently, there was an opportunity to introduce constructivism in curriculum development when Singapore Maritime Academy collaborated with Maritime Institute Willem Barentsz of The Netherlands to offer Bachelor of Maritime Operations Degree jointly. This paper describes this student-centric curriculum development process and argues the merits of such practices, which may be a viable option to consider. Inquiry-based methods supported by concept mapping techniques were used to create a content ontology.

BACKGROUND

> *Constructivism is basically a theory -- based on observation and scientific study -- about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and experience, maybe changing what we believe, or maybe discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. To do this, we must ask questions, explore, and assess what we know.* (Matsuoka, 2004)

Although the case for student-centred learning is frequently emphasized, implementation of constructivist learning environment at curriculum development level is restricted to perhaps modularisation of content in many institutes of post secondary education. The modules provide some level of choice for the students. However, once the choice is made, the prescribed curriculum for the module is usually thrust on to the learners, who would then resign to accept the familiar top-down approach of the curricular processes.

The practices at the Singapore Maritime Academy are not different from the above. With a pre-defined curriculum, the instructor prepares a set of instructional slides and disburses them efficiently for the benefit of large bodies of learners in classrooms and lecture theatres. The learner interactions are also restricted to few bold individuals in class, who would normally raise their hands and wait for their turn to be answered.

Bruce and Bishop (2002) referred to traditional curricula as the medium with emphases for the delivery of content, where the role of the teacher is to manage this delivery and the role of the learner is to absorb this delivered knowledge. Hence, "*covering*" the curriculum becomes the priority of such a system. They claimed that this prevailing system of curriculum may not be adequate for today's world and there is acute need for today's students to become active learners, to be able to collaborate and understand the perspectives of others. Hence, they stressed the followings skills to be incorporated in curriculum design:

> *... they* (learners) *need to learn how to learn, and they must ask (find problems), investigate (multiple sources/media), create (engage actively in learning), discuss (collaborate and debate), and reflect to do that.* (Bruce and Bishop, 2002)

Recently, a course (Bachelor of Maritime Operations) was jointly offered by the Singapore Maritime Academy (SMA) and Maritime Institute Willem Barentsz of The Netherlands (MIWB). The course structure is shown in Figure.1. The module being considered in this paper is called *Diesel Technology & Emissions*, which is covered under the *Marine Engineering Options.*

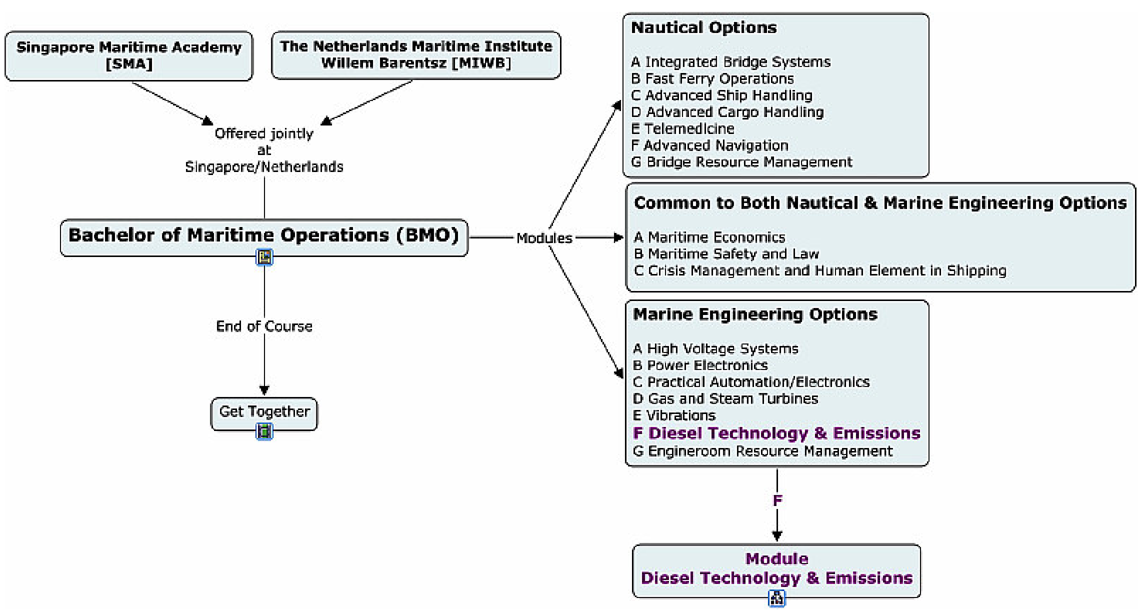

Figure 1. Module Diesel Technology & Emissions in the BMO Course Structure

[CmapTools Screenshot]

The synopsis for the module *Diesel Technology & Emissions* was provided by MIWB and SMA had the responsibility of translating the same into course objectives and relevant content. In the first BMO cohort, there were ten students and five of them took the Marine Engineering Options. With such a small group, I had the discretion of using a networked computer lab instead of a normal classroom. The networked computer lab opened the possibility of technology-infused, inquiry-based collaborative learning and thereby provided the learners the opportunity *to ask questions, explore, assess what they know*, (Matsuoka, 2004) and finally validate their findings through a collaborative discourse. A collaborative discourse structure provides a platform for group discussion and helps to capture and categorize the outcome of such discussion. (Turoff et. al. 1999)

During this module, concepts maps (Novak and Gowin, 1984) were used to help the learners in the process of reflective inquiry (Barr, Barth and Shermis, 1977), capture and categorize their findings. Later the learners used these findings for group discussion and negotiations. These led to the development of the content based on the synopsis provided by MIWB and enhanced the existing knowledgebase of the learners and their own understanding of the subject matter. The resulting constructivist knowledge created, has strong ownership claims of the learners and is now ready for re-use and rehash by the next cohort of students.

In brain research, Gibson and McKay (2001) provide some insight to this constructivist view of knowledge and the role of the knower in constructing that knowledge. They claim that tenets of constructivist theory supported by brain research necessitate radical change in the design and implementation of curricula. Such curriculum would allow multiple realities and multiple ways to create, express and represent those realities. Such curriculum change would encourage the learner as an active constructor of his or her own meanings within a community of others who provide a forum for the social negotiation of shared meanings. Hence, it would reflect the complexity of the meaning making process and require complex learning environments that would enable such meaning making.

The next section relates the process of these learner inquiries/ group negotiations undertaken during the module and the resulting creation of the subject ontology and related content, which bear a strong collaborative ownership of the learners unlike the prescriptive, much less student-centric, top-down traditional curriculum.

LEARNER INQUIRES & KNOWLEDGE AND INFORMATION VISUALIZATION

> *Leveraging on … modern computer-based mapping tools… an integration of knowledge and information visualization has the potential of impacting, the management of knowledge, information and education in a variety of context, among them self-regulated resource-based learning, sense-making information visualization and cross-community knowledge & information exchange.* (Novak et. al. 2002)

One way of engaging students in a class is to assign them with activities and provide specific goals. This was done to switch the students from the usual passive modes that they are so familiar with in classrooms. The specific goals were to create knowledge-based artefacts using CmapTools, a software suite (some details of CmapTools are given under Glossary) from the Institute for Human and Machine Cognition (IHMC). The CmapTools were available on the networked computers in the computer lab and the learners were asked to familiarise with the same.

The synopsis received from MIWB was given to the learners for brainstorming. After discussion and lengthy deliberations with the facilitators, the sub-modules were named and various course strategies were discussed and finalized. The information visualization was used extensively through CmapTools software suite. The complete process of module implementation is shown below in the Figure 2. Once the strategies were finalized, extensive literature search was carried out using Google Search Engine. Hardly any documents was available at the library, as the MIWB synopsis referred to the latest changes in propulsion machineries in maritime transportation due to the recent introduction of stringent environmental regulations with respect to exhaust emissions of these propulsion engines.

Group work and individual work were also identified and agreed upon during the classroom sessions. Resources collected through the literature search were stored in the concepts identified (using CmapTools) and most of the principal resources were converted to PowerPoint slides by the learners and presented in the class. The resulting knowledgebase was captured using CmapTools software suite and uploaded to the CmapTools Public server for sharing in the public domain. The complete knowledgebase for the module, developed as an educational artefact through student inquiry during the running of the course, is available at the following http address.

http://cursa.ihmc.us/servlet/SBReadResourceServlet?fid=1159368481365_703199681_640

The knowledgebase developed will go through further upgrading and refinement during future runs of this course. The concepts or the nodes created can also be enriched by adding additional resources at these nodes. Additionally, the nodes could be extended by giving depths (*by adding levels to the nodes/ concepts*) or breadth (*by adding additional nodes/ concepts*). The overall structure of the knowledgebase may also go through changes as the domain understanding transforms over period of time. So, it is argued that this curriculum plan for the module will provide a conducive environment for the growth of a dynamic constructivist knowledgebase, which will be updated by each cohort of learners over time.

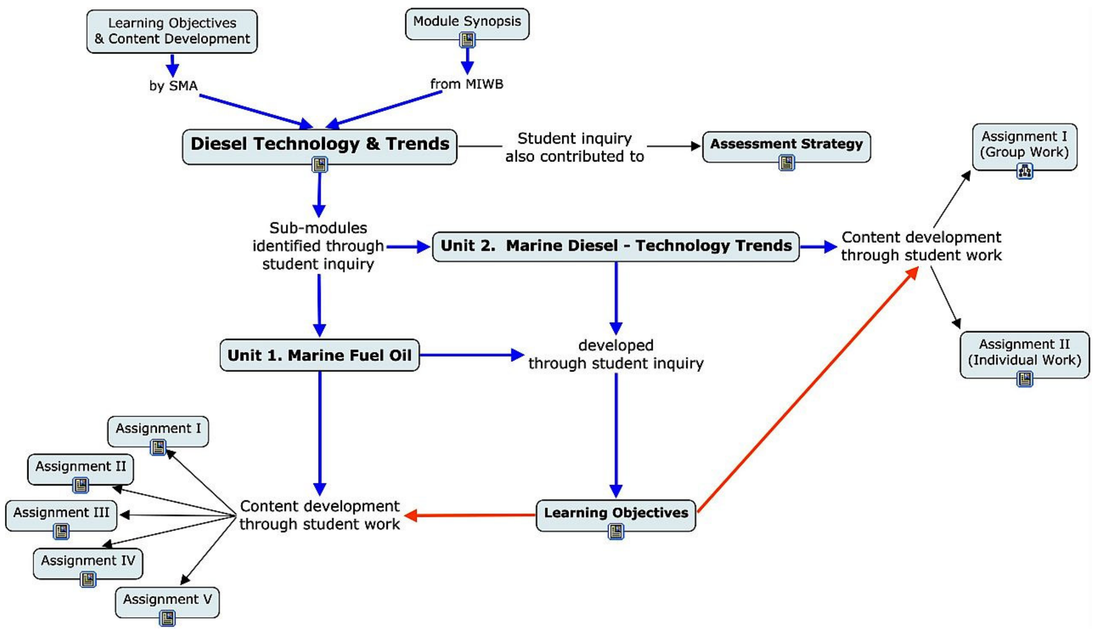

Figure 2 Module implementation through student inquiry [CmapTools Screenshot]

ANALYSIS AND COMMENTARY

The student inquiry process led to many positive attributes as identified by the students at the end of course feedback. These were, as they claimed:

- scope for research,
- independent learning,
- exposure to new learning technology,
- scope for presentation of individual/group work,
- group work which led to better understanding,
- open communications between facilitators and the learners,

- the open concept of learning,
- novelty aspect of this method of learning and finally there was
- scope for individual creativity.

While the learners acknowledged these positive aspects, they also complained about

- inadequate training in CmapTools,
- too many assignments, and lastly expressed
- unhappiness about the time-consuming processes, where they had to sieve through volumes of content in the Internet to find what was relevant.

Looking at the feedback, it was felt, that as an initial effort, the inquiry-based approach received largely positive feedback from the small group of learners, who took part in this educational experiment. It was possible to involve the learners during each lesson and obtain their sincere commitment in developing an educational artefact, which was created mainly during classroom processes. However, form the negative comments of the learners, it was concluded that further scaffolding is required during classroom processes to reduce stress and make learning more enjoyable during the next running of the module.

LESSONS LEARNED

> *There is today almost universal agreement that every learner must construct her/his own knowledge structure, or cognitive structure, through her/his own efforts. The commitment to building a powerful knowledge structure must be the learner's commitment. There is less universal recognition that knowledge structures are built*

primarily through meaningful learning, and by contrast, rote learning or simply memorizing information contributes little to building a person's knowledge structure.(Novak & Cañas, 2004)

While constructing one's own knowledge structure is *sine qua non* for assimilation of new knowledge for a learner, as highlighted in this paper, many times, the beginners in any domain may start with a wrong concept. If the wrong concept is not addressed, all additional learning may have an incorrect foundation and the process of unlearning this misconception may become problematic for the learning facilitator. A way round this is to develop a set of expert skeletal concept maps on the basic issues in the domain, which could provide the right foundations for the learners and they can subsequently build the additional concepts and add these to the expert skeletal maps. This is highlighted in the following paragraph by Novak & Cañas (2004).

An important advantage of organizing instruction beginning with an expert concept map is that learners and teachers almost always have faulty knowledge or misconceptions in virtually every domain of knowledge that has been studied. Research has also shown that these misconceptions are notoriously difficult to overcome with traditional instruction. The use of concept maps has been shown to be effective for remediating misconceptions, especially when learners begin with a valid "expert" concept map and when they work collaboratively to construct a new knowledge model.

In this project, our learners identified the basic issues of the domain (using inquiry-based learning approach). It will be prudent in future running of the module to produce expert skeletal maps, which will provide the students with additional scaffolding. Subsequent student work can then be continued as new concepts and knowledge are found by adding to these expert skeletal maps to enhance the knowledgebase as a continuous dynamic process. Hence, these maps could provide the *right direction* for the knowledge growth. An example of an expert skeletal map in the area of boiler combustion is given in Figure 3 below. Deliberate incomplete areas are left for the learners to add concepts and new knowledge.

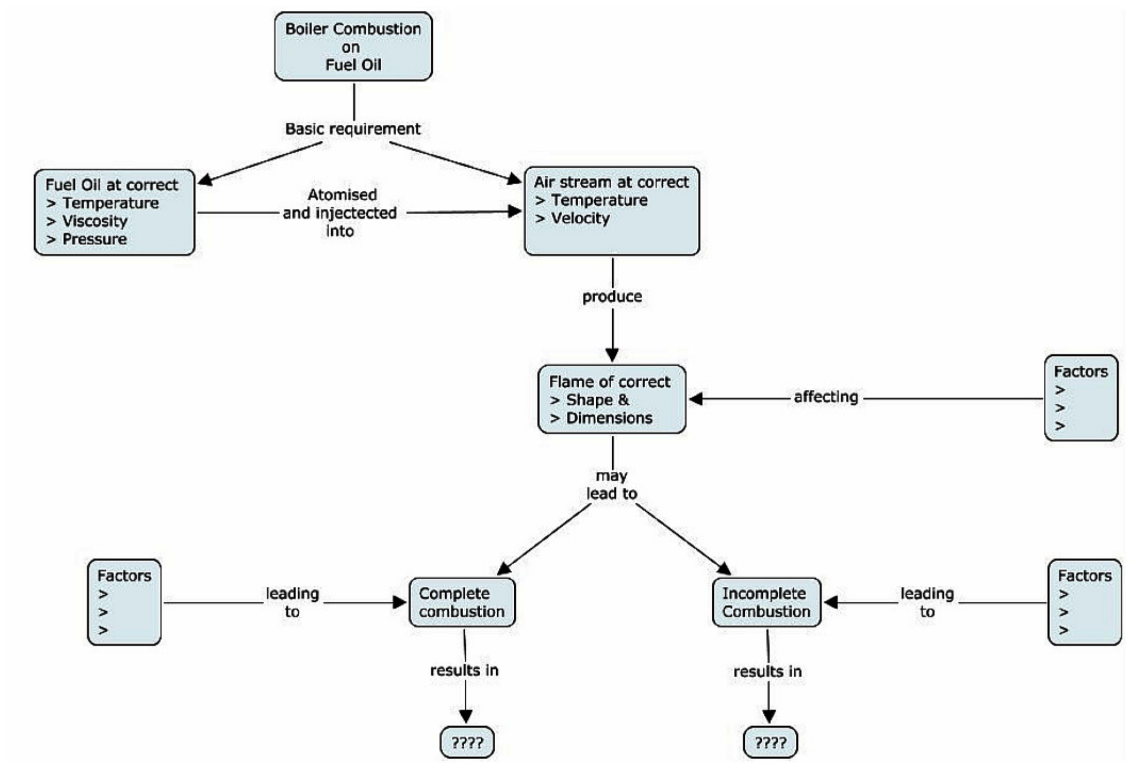

Figure 3 Example of an Expert Skeletal Concept Map [CmapTools Screenshot]

CONCLUSION

The paper related the work undertaken at the Singapore Maritime Academy to run a module, jointly offered in a course by MIWB and SMA, on the principles of inquiry-based learning. The classroom processes were conducted using a concept mapping software, CmapTools from IHMC, USA. This new initiative at the Singapore Maritime Academy attempted to develop a module curriculum as well as content-generation using constructivist collaborative classroom processes. The experiments conducted with CmapTools software suite provided knowledge visualization to the participating learners and the facilitators. According to Novak and Cañas (2006), knowledge creation by individuals facilitates the process of learning for the learners. Normal lecture classes were replaced with *knowledge laboratories* to develop and refine knowledge-based artefacts in the subject domain. The knowledgebase generated was uploaded to the CmapTools Public Server for worldwide sharing and comments. The inquiry-based learning and knowledge-visualization techniques seem to offer an engaging environment for learners in a classroom situation to promote constructivist curriculum development and content generation.

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GLOSSARY AND SOFTWARE DETAILS

CmapTools	The Institute for Human and Machine Cognition (IHMC) of University of West Florida developed a software suite called CmapTools, which is the resulted outcome of many years of research by Professor Joseph D. Novak (presently the Emeritus professor of Biology & Education, Cornell University, USA and Senior Research Scientist at IHMC). CmapTools allows users to construct concept maps to represent large bodies of knowledge. CmapTools supports splitting of large subject domains to be divided into levels of concept maps and relationships. ***The CmapTools client is free for use by anybody****, whether its use is commercial or non-commercial. In particular, schools and universities are encouraged to download it and install it in as many computers as desired, and students and teachers may make copies of it and install it at home. (Commercial companies that install their own CmapServer do need to get a separate license for a CmapTools client that will talk to the commercial version of the CmapServer). [From http://cmap.ihmc.us/]* CmapTools creates a domain of knowledge referred to as *Knowledge Model*, which consists of series of concept maps. A concept map has *concepts* and their *inter-relationships.* The concepts are populated with *resources* e.g. media files, texts, URLs, slides as well as concept maps at other levels (Cañas et. al., 2003). Each concept could be well defined through the use of these resources. Then keywords or phrases are used to inter-relate these concepts, which are

	known as *meaning-making* in the knowledge domain. Cmap*Tools* could also be used for collaborative learning and could be uploaded to the server for worldwide sharing. These knowledge models could also serve as *learning objects* and a combination of them would make a bigger knowledge model. Each concept map could be made just the right size for learning – making them manageable for various target groups of learners.
SMA	Singapore Maritime Academy, 500 Dover Road Singapore 139651.
MIWB	Maritime Institute Willem Barentsz of The Netherlands, NOORDELIJKE HOGESCHOOL LEEUWARDEN, Instituut Techniek, Tesselschadestraat 12. 8913 HB Leeuwarden. NL
IHMC	The Institute for Human and Machine Cognition (IHMC) of University of West Florida, USA.

AUTHOR'S BIOGRAPHY

Kalyan Chatterjea started his career as a sea-going engineer and sailed for eleven years rising to the rank of Chief Engineer. Presently, he is a lecturer at the Singapore Maritime Academy for the last seventeen years. Prior to that, he worked in the Design Department of the Sembawang Shipyard, Singapore for seven years. Earlier to that, he was also at the office of the Directorate General of Shipping in India as a Ship Surveyor and Examiner of Engineers for two years. He holds an Extra First Class Certificate in Marine Engineering in Steam & Diesel from Department of Transport, UK, a Master of Science in Systems, Control and Information Technology from University of Sheffield, UK and a Master of Education from University of Sheffield, UK. His present interests are in technology-mediated maritime education and knowledgebase systems.