

DEVELOPING A FLEXIBLE LEARNING MODEL USING LEARNING OBJECTS ... A CASE STUDY AT THE SINGAPORE MARITIME ACADEMY

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Abstract

With availability of technologies a student-centred flexible model of education could promote personalized learning. A case study was conducted at the Singapore Maritime Academy using computer-mediated learning, where students were encouraged to develop learning objects as part of their course work. The learning objects were made using concept mapping tool and were enriched with spatial resources at multiple levels. The resulting knowledgebase developed through student-centred activities created a collaborative, enjoyable learning platform for learners and at the same time produced dynamic searchable digital resources. An on-demand networked formative assessment system was also provided to scaffold learning. The paper describes the details of this case study and the feedback received from the first cohort of learners going through this experiment.

Keywords: *Learning objects, resource-based learning, formative online assessment, CmapTools, concept maps, knowledge sharing, knowledge repositories, computer supported collaborative learning.*

INTRODUCTION

...flexible approaches to teaching and learning refer both to an educational philosophy and a set of techniques to teaching and learning. The term describes an approach to education that is more a learner-centred and that increases the learner's responsibility for his or her own learning. Flexible approaches increase the degree of student control over when, what, where, how and at what pace they learn. (Johnston, 2001)

Unlike the conventional classrooms, where teachers act as main players in the teaching and learning activities of the learners, a flexible model of education promoting personalized learning can create environments, where learners play the key-role in their learning. In such models the learners define their own needs and seek for solutions. This course of defining one's own needs and the seeking of their solutions leads to processes, which could precipitate in *meaningful learning* (Cañas et al. 2003). Recently, a case study was conducted at the Singapore Maritime Academy (SMA), where such a model was attempted. The model was based on student activities resulting in development of reusable *learning objects* (Hodgins, 2002). Learning objects are small, self-contained entities, with their own objectives, activities and assessment. The paper describes the case study and presents arguments that this student-centred approach is one of the viable models for technical education.

The application domain selected is LNG transportation industry, which uses LNG boil-off gas to fire propulsion boilers for a steam propulsion plant. Human resource in this sector

is in short supply as the today's marine engineers are mainly trained on diesel engines. Hence, there is an acute need to convert management level diesel engineers with ample diesel propulsion proficiency to steam propulsion engineers with additional expertise of LNG gas handling in steam boilers and of operating the steam propulsion plant. The case study was based on developing a course for imparting this steam engineering knowledge to engineers proficient in running of diesel propulsion machinery.

The SMA course, titled "*Steam Certificate of Competency for LNG Propulsion*" is tailored for the emerging LNG transportation sector, which trains adult learners, who are already engineers on diesel ships and who will be further trained for certification in handling LNG carrier in steam propelled vessels burning boil-off gas from the LNG cargo. Using this course as a case study, the plan was to develop an ergonomic learning environment, created through computer mediation.

This new learning environment is expected to facilitate:

- Creation of learning objects during course to facilitate personalised learning
- Use of advance organisers to enhance assimilation
- Automated formative assessment to scaffold learning
- Constructivist social learning to promote teamwork
- Inquiry-based and exploratory learning to synthesize knowledge

Normally, this course is run for a period of three months. Use of this flexible, computer-mediated environment is expected to cut down the training time to only four weeks, which is 1/3rd of the normal duration of such a course. The paper describes the process of running of the first cohort, which was undertaken during the month of March, 2007 at the Singapore Polytechnic.

The paper is organised in the four following sections:

- Section 1 narrates the process of learning objects generation in the context of *constructivist flexible learning* (Bannan-Ritland et al., 2000).
- Section 2 describes the *resource-based learning* (Hannafin et al. 2000), *which offers the potential for establishing situational relevance in a flexible development/delivery environment.*
- Section 3 relates the techniques used for the development of a network-based on-line assessment system, which formed an integral part of the course providing scaffolding for the learners.
- Section 4 summarises the feedback from the 1st cohort.

SECTION 1 – LEARNING OBJECTS

Learning objects are fundamental elements of a new conceptual model for content creation and distribution. They are destined to change the shape and form of learning, ushering in unprecedented efficiency of content design, development, and delivery. Their most significant promise is to increase and improve the effectiveness of learning and human performance. (Hodgins, 2002)

Learning objects (LOs) have been defined in various ways (Bannan-Ritland et al., 2000; Wiley, 2000; Hodgins, 2002; Lezama, 2006) and is now seen as a topical issue in teaching and learning. Learning objects provide a development platform, which lends itself to flexible usage in course building. With the availability of ample digital resources, learners could be led through constructivist ways to deconstruct knowledge resources and reconstruct the same to suit their individual learning needs. Although the LOs are developed to meet the

requirements of a specific course, being self-contained in nature, they are reusable in other courses if the courses share similar objectives.

In the case study at the Singapore Maritime Academy, LOs were put together by the learners themselves as Bannan-Ritland (2000) and Gibbons (2002) suggest that *if the learner acquires an author's role during LO generation, learning will be more significant and the learning object will turn into a fundamental element of the learning process in virtual environments.*

The basic course structure is shown in the figure 1 below. *Knowledge* components (shown as 64% below) are the content knowledge of the steam plant and constituted of MS Word documents, PDF documents, html files, graphics and videos, while the *proficiency* components (shown as 36% below) were mainly delivered using the LNG Steam Propulsion Plant Simulator, which could simulate various scenarios of a running plant. The *basic thermodynamics* (shown below in Figure 1) is a set of help files, which provides the *look-up* facility in thermodynamic theory, which may be required for the engineers from time-to-time to run the plant and understand its behaviour.

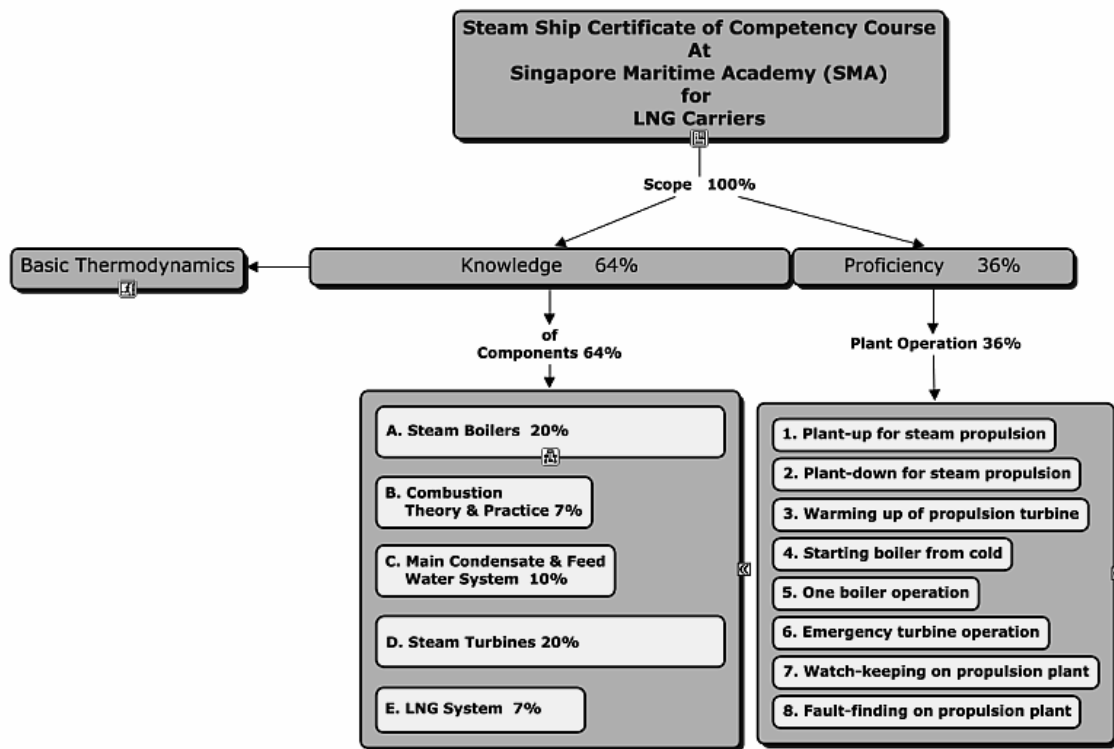


Figure 1. Course Structure for the Case Study

The course structure is deconstructed (see Fig. 2) using an advanced learning organiser to split the task of running of the plant into a combination of smaller tasks. The learning organiser has the purpose of visualizing the overall sequential tasks at-hand and also providing interface for accessing resources via this visual organiser. It is expected that as the learners go through these sequential tasks, they would pick up the essential knowledge and proficiency required covering the majority of the course structure shown in Figure 1.

The tool used for this development is CmapTools from the Institute for Human and Machine Cognition and is described elsewhere (Cañas et al., 2003; Novak & Cañas, 2004; Chatterjea, 2006, 2007). The sequential path shown in the Figure 2 has twenty nodes (marked by numbers *nn*) and the nodes have direct access to various documents, graphics, media files

and other similar learning organisers at a lower level (see Figure 3). The learning objects are made by the learners at this level. As an example, taking the *safety devices* from Figure 3, a learner has developed a learning object on protective devices on boiler (see Figure 4) using a concept map. The actual processes of the development of concept maps are described elsewhere (Cañas et al., 2003; Novak & Cañas, 2004; Chatterjea, 2006, 2007).

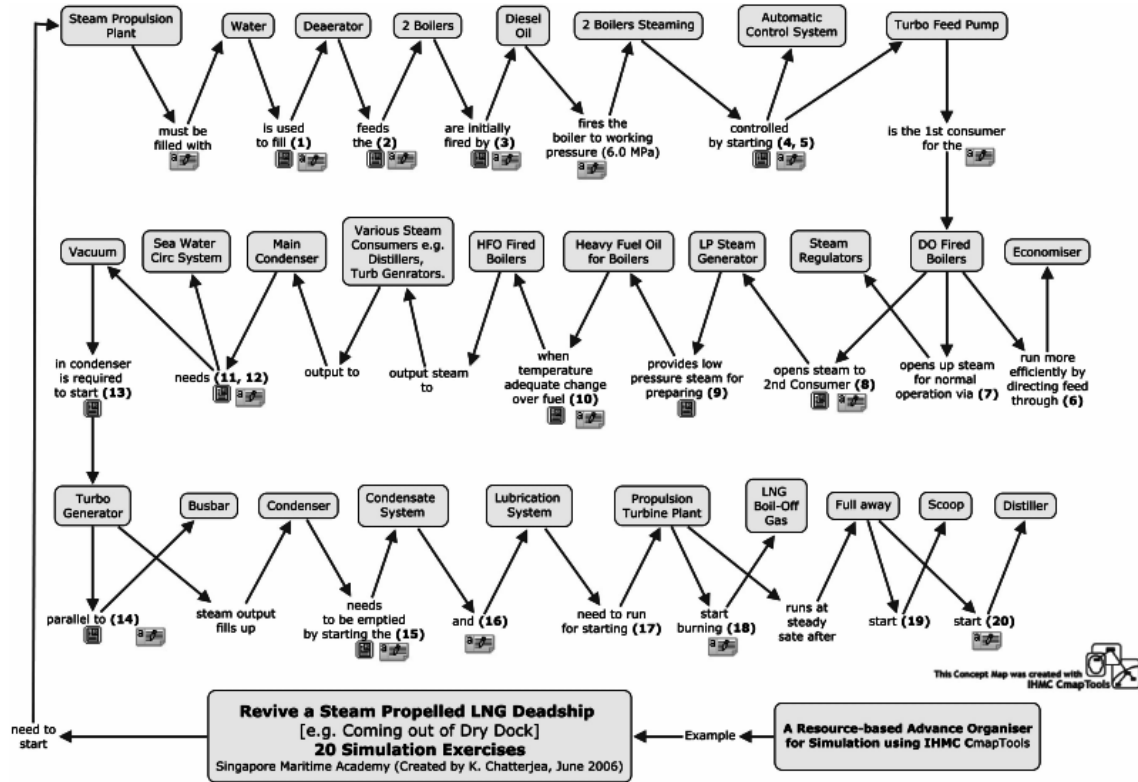


Figure 2 Advance Learning Organiser Provides a Visual Interface for Resource Access

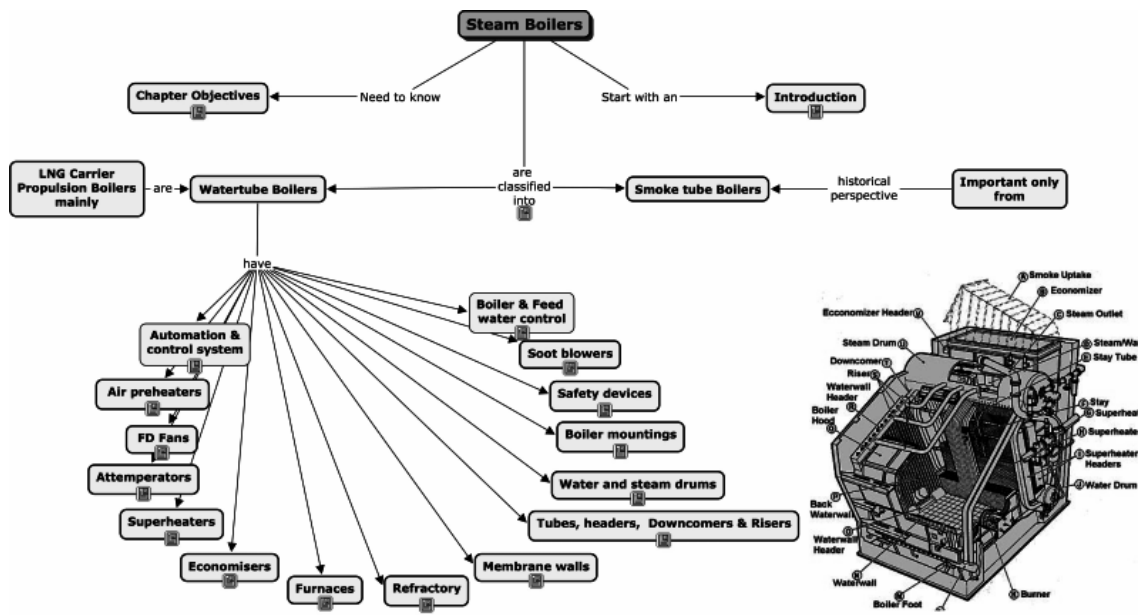


Figure 3 Visual Organiser at a Lower Level for Steam Boiler

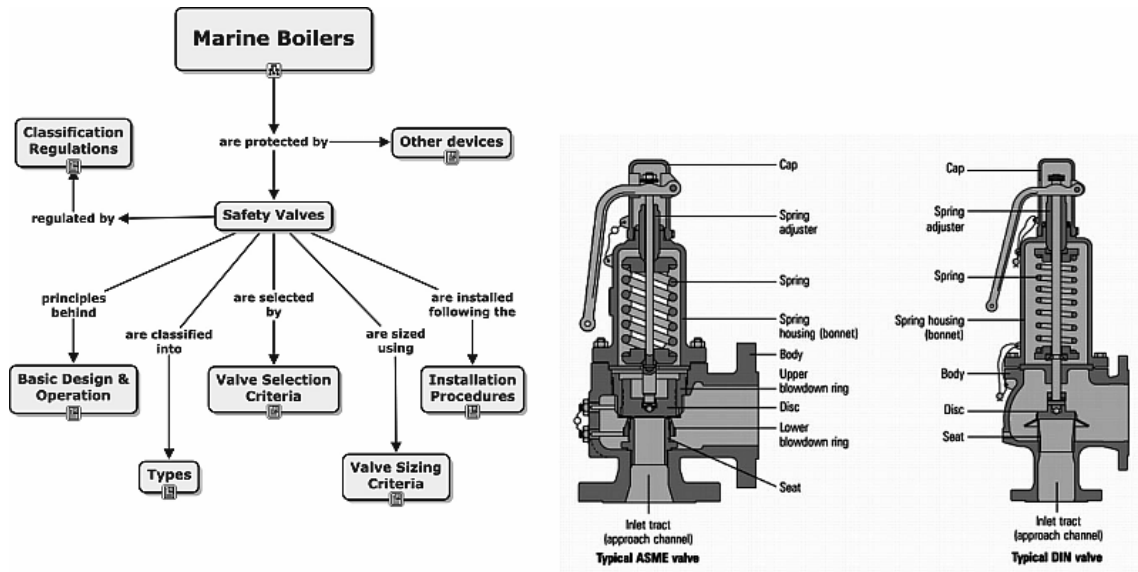


Figure 4 Learning Object - Boiler Protective Devices

The main features of learning objects and their advantages for different groups of users are shown in Figure 5 (Lezama, 2006). Benefits of reusability of these LOs are already being realized in SMA as the LOs are being re-used in other courses with similar objectives. CmapTools has an in-built search engine and scope for meta-tag definitions, so if the LOs are well-defined with meta-tags, locating the LOs does not pose any problem. Granularity is expected to increase with each cohort as the learners will progressively develop more LOs at lower levels. CmapTools lends itself easily for scalability as the LOs could be arranged in various groups at different levels.

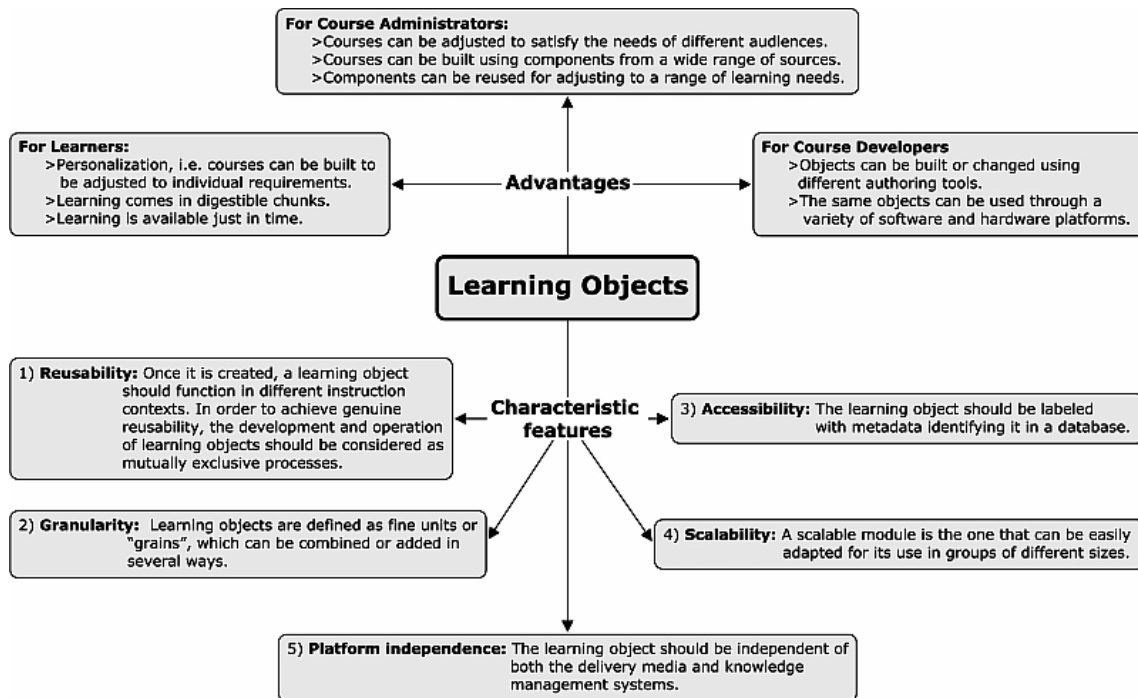


Figure 5 Learning Objects - Main features & Advantages

The LOs made with CmapTools can be attached with various resources. Resources-based learning (RBL) is another topical issue in education (Bell & Lefoe, 1998; Hill, & Hannafin, 2001). RBL and its implications in teaching and learning, as implemented in the case study, are discussed in the next section.

SECTION 2 – RESOURCE-BASED LEARNING

Knowledge and related information has to be structured in a way that it can be accessed easily. Visualization tools may assist students in visualizing their knowledge, as well as providing access to knowledge elements and task-relevant knowledge resources. Most existing tools focus on the visualization of knowledge or information only. It is claimed that concept mapping may function as a bridging technology. The contribution draws attention to digital concept maps as cognitive tools which may provide a basis for the development of synergistic approaches that may help visualizing, accessing, and managing both subject-matter domain knowledge and information and foster resource-based learning. (Tergan et al., 2006)

Strategies for flexible learning should include effective organisation and representation of knowledge. Localisation of knowledge using concept mapping tools can provide resources for self-regulated resource-based learning (Tergan and Haller, 2003). Concept mapping tools support situational relevance on spatial representations, which could breakdown complex learning tasks into manageable learning objects, with their own resources. Graphical representations in concept maps enhance cognitive process of managing knowledge and information in resource-based learning and problem solving environments (Cox, 1999).

In self-regulated learning, availability of increasing volume of digital information many times leads to cognitive overload. Additionally, conceptual and navigational disorientation is common among learners while surfing the Internet for making sense in an un-familiarised domain (Tergan et al., 2006). Concept maps used in the case study provides localized resources and thus addresses the problem well. Advance learning organisers based on concept maps (see Figure 2, 3 & 4) provide spatial resources and thereby support individual knowledge management. An example of resources in the concept map, generated in the case study is shown in the Figure 6.

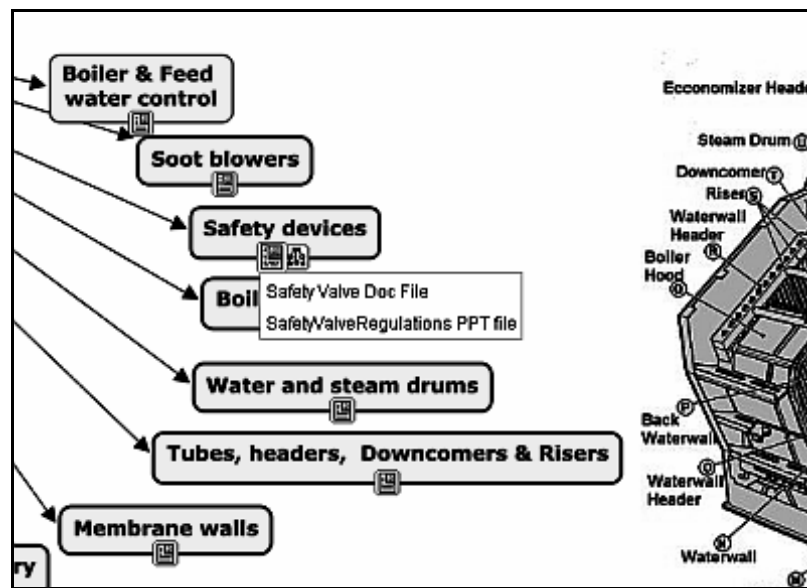


Figure 6. Localised Resources for Safety Devices - doc file, ppt file and LO at a Lower Level

According to Boechler & Dawson (2002), concept maps could become useful in helping individual in his search for knowledge and knowledge resource. In this sense visual search in computer-based knowledge maps resembles map-based navigation in hypertext environments. In addition to visual search most computer-based mapping tools provide functions for content search, thus providing automatic access to pre-specified knowledge elements (Tergan, 2003).

Considering that a learning system is not complete without a fitting assessment arrangement, we spent considerable resources to develop on-demand online assessments for all the LOs, which were developed during the case study. The next section provides some details of this assessment system, which was created using ExamView suite from FSCreations, USA.

SECTION 3 – ONLINE ASSESSMENT IN ENHANCING LEARNING

Assessment practices shape, possibly more than any other factor, what is taught and how it is taught in schools. At the same time, these assessment practices serve as the focus (perhaps the only focus in this day and age) for a shared societal debate about what we, as a society, think are the core purposes and values of education. If we wish to create an education system that reflects and contributes to the development of our changing world, then we need to ask how we might change assessment practices to achieve this. (Ridgeway et al., 2006)

There is evidence that today's educational requirements call for higher order thinking. However, it is also claimed that there is a constant danger that assessment systems are driven in undesirable ways, where things that are easy to measure are valued more highly than things that are more important to learn but harder to assess. (Ridgeway et al., 2006)

Computer-mediation can help provide on-demand online tests with immediate feedback. In the case study for all LOs, there were specific on-demand online tests. The Figure 7 shows the process of developing an online network-based objective type of question. The software suite used is called ExamView (<http://www.fsc creations.com/examview.php>), which is suitable for both non-numeric and numeric online questions. Assessments were arranged in formative mode with *low stakes*, which means, the learners were encouraged to attempt these assessment even when they were unsure of the solutions. The immediate feedback from the server provided the grade achieved, the right answer and its rationale. Hence, the assessment system served somewhat like Skinner's *teaching machine*, used so successfully in programmed learning (<http://www.coe.uh.edu/courses/cuin6373/idhistory/skinner.html>).

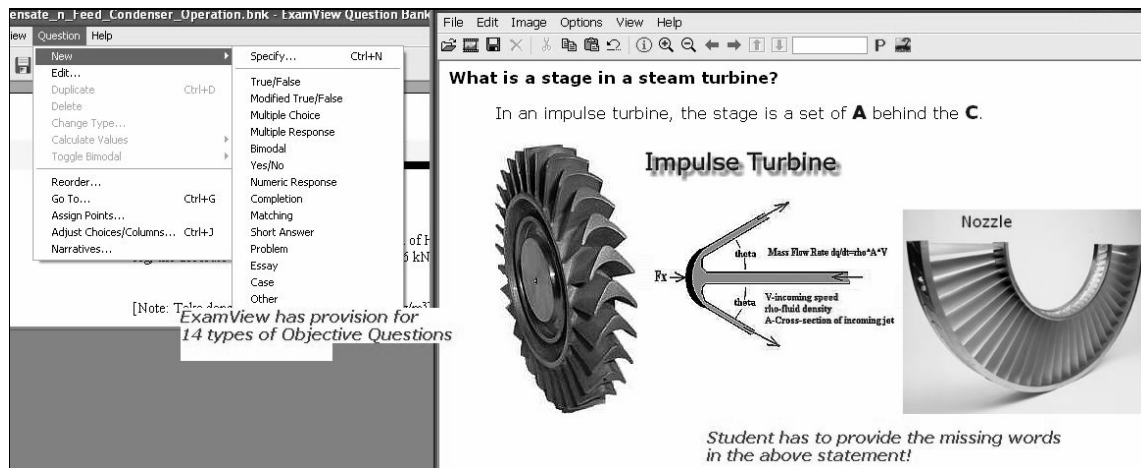


Figure 7 Assessment Development using ExamView Suite

The association between teaching, learning and assessment is well explained by Robitaille et al. (1993) distinguish three components of the curriculum: the intended curriculum (set out in policy statements), the implemented curriculum (which can only be known by studying classroom practices) and the attained curriculum (which is what students can do at the end of a course of study). The links between these three aspects of the curriculum are not really clear. Hence, according to Ridgeway et al. (2006), *the assessment system – tests and scoring guides - provides a far clearer definition of what is to be learned than does any verbal description (and perhaps provides the only clear definition), and so is a far better basis for curriculum planning at classroom level than are grand statements of educational ambitions.*

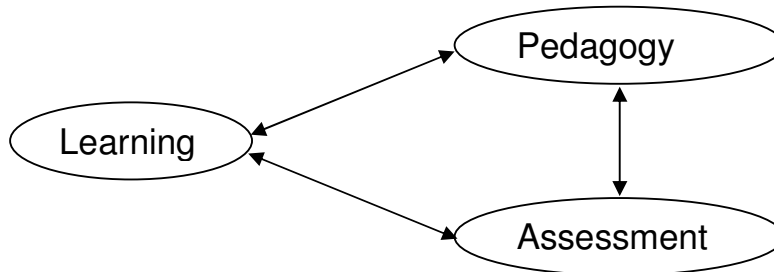


Figure 8 Close Association between Learning & Assessment
[Adapted from Pellegrino, Chudowski, and Glaser, 2001]

The learners were given 10 to 12 online formative assessments per week to self-evaluate their progress. At the end of the course, there was also an online summative assessment, which was served to establish the grade of the learner and was also used by Maritime Port Authority of Singapore to issue the required certification in steam engineering knowledge. The Figure 9 shows some of the formative assessment on the server and a part of one assignment.

Singapore Polytechnic Steam COC for LNG Propulsion Kalyan Chatterjea		Boiler In-Course Assessment 01	Boiler In-Course Assessment 02	Boiler In-Course Assessment 03	Boiler In-Course Assessment 04	Boiler In-Course Assessment 05	Boiler In-Course Assessment 06	Boiler In-Course Assessment 07	Boiler In-Course Assessment 08	Boiler In-Course Assessment 09	
Name	Student ID	03/09 Benchmark Term 1 26 pts	03/12 Benchmark Term 1 16 pts	03/13 Benchmark Term 1 12 pts	03/13 Benchmark Term 1 4 pts	03/13 Benchmark Term 1 5 pts	03/14 Benchmark Term 1 5 pts	03/15 Benchmark Term 1 17 pts	03/15 Benchmark Term 1 12 pts	03/15 Benchmark Term 1 9 pts	03/16 Benchmark Term 1 12 pts
Changreth, Vinod Kumar	Vinod	26	16	12	4	5	5	17	12	9	10
Chatterjea, Kalyan	Kalyan	22	16	12	--	--	--	0	--	--	--
George, Gibi Ndumpurath	George	26	16	12	4	5	5	18	12	9	12
Gopinath, Kuppusamy	Gopinath	24	16	12	4	5	5	16	12	9	12
Haque, Md. Ahsanul	Ahsan										
Moe, Zaw	Zaw										
Rajadhyax, Shailesh Vithal	Shailesh										
Sasane, Bharat	Bharat										
Singh, Praveen	Praveen										
Sinha, Anupam	Anupam										
Tha, Kyaw	Kyaw										
Average											

Boiler Protection - Safety Valves

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1.

The blowdown rings on an ASME type safety valve

What is the primary function of Boiler Safety Valves?

- a. To maintain the boiler pressure within safe limits as the load changes during operation.
- b. To protect life and safeguard boiler.
- c. To safeguard steam piping and equipment downstream of boiler.
- d. To allow gradual release of overpressure in the event of overloading.

Figure 9 Formative Assessment and Scores on Server

As all the details of student performances are recorded, the difficulties in understanding of a part of the content are immediately highlighted and necessary actions could be taken by the facilitator. The digital assessment and scores were recorded in the server and creates a good transparent means of developing student portfolios (ExamView has built-in facility for generating student progress report). The student portfolios will provide the potential employers a clear picture of the course coverage and also all stake holders could provide feedback on coverage, thereby allowing the provision for critical evaluation of course content and progressive improvement of the course structure.

Learner feedback was also made a part of the server-based process and these are discussed in the following section.

SECTION 4 – FEEDBACK FROM THE 1ST COHORT

The learner expectations based on his past learning experiences in a learning situation could pose difficulties in accepting new ways learning (Fidishun, D. 2000). Quoting Fidishun, *adults resent and resist situations in which they feel others are imposing their wills on them*. In the case study, we were dealing with senior engineers, who already had substantial experience of post-secondary education and therefore had distinct expectations about the way a course should be delivered and run. So, to sell a totally new way of learning was indeed a challenge for the course facilitator. Even the classroom arrangement (see Figure 10 below) was very different from the conventional ways of learning in a classroom.

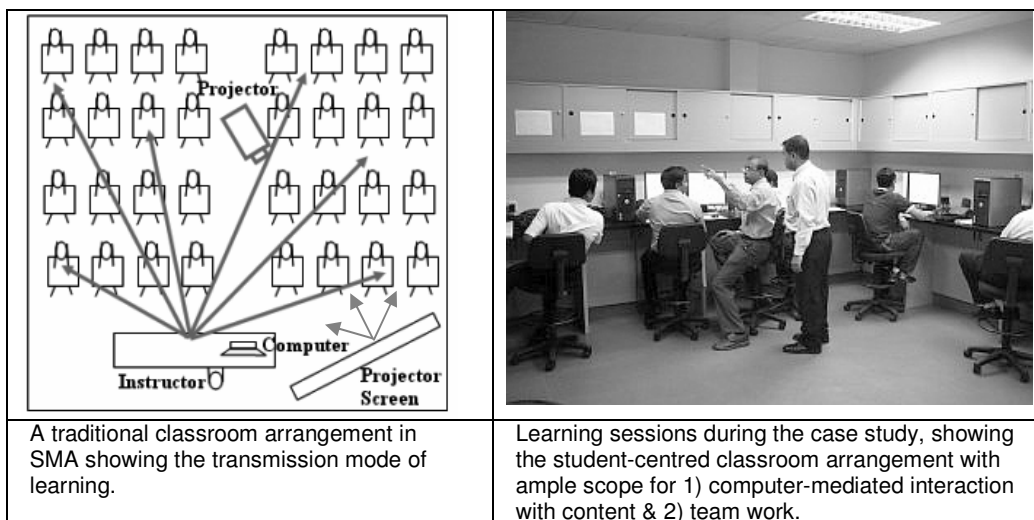


Figure 10 Comparing Classroom Arrangement during the Case Study with the Conventional Arrangement at SMA

However, the feedback received was generally positive and would encourage us to pursue this new way of computer-mediated learning for maritime education at the SMA. The following table summarizes the feedback received from the 10 mature students in our first cohort.

Feedback to Improve Learning (n=10)	
Questions	Feedback
1. List out the <i>useful</i> features of the module.	<ul style="list-style-type: none"> ○ Course was information rich ○ Use of Internet to study ○ Sharing of course material among participants ○ Knowledge-based learning ○ Group learning

	<ul style="list-style-type: none"> ○ Team work ○ Hands-on experience on steam simulator gave us a realistic view of LNG ship operation ○ Good coverage ○ Video of LNG ship ○ Use of CmapTools suite ○ Use of ExamView software ○ Updated information on subjects ○ Computer-mediated learning drives our interest to learn more ○ Assess ourselves everyday with immediate feedback ○ Course gave us confidence on running of LNG ships
<p>2. List out the <i>NOT so useful</i> features of the module.</p>	<ul style="list-style-type: none"> ○ Nil
<p>3. What are the <i>strengths</i> of the module?</p>	<ul style="list-style-type: none"> ○ New approach to learning <ul style="list-style-type: none"> ⇒ Time saving ⇒ Better in-depth understanding ⇒ Direct involvement with content during course ○ Computer-based learning ○ Good coordination of course-coordinator ○ Use of CmapTools & ExamView ○ Exposure to new ways of learning ○ Ample scope for group discussion during the course ○ Learning with a partner ○ Freedom to research and make assignments using software
<p>4. What are the <i>weaknesses</i> of the module?</p>	<ul style="list-style-type: none"> ○ This method of teaching may not be effective for those who are expecting to spoon feeding. ○ Cannot find any flaw in this method of learning. Given a choice between traditional learning and this method, I shall choose the later. ○ Student without having some minimum knowledge of computing will find this course difficult. ○ No shipboard visit
<p>5. Was the module <i>enjoyable</i>?</p>	<ul style="list-style-type: none"> ○ Module was really interesting ○ Very interesting and informative ○ Very friendly and informal environment ○ Very enjoyable throughout the course ○ All the way yes
<p>6. Why choose Singapore? **</p>	<ul style="list-style-type: none"> ○ Cost effective and I find Singapore to be a homely environment ○ Cheaper and yet the course is using a lot of technology ○ Faculty is knowledgeable ○ Singapore is more advanced in computer usage ○ I continued from my earlier course in

	Singapore. So it was convenient
7. Any other comments.	<ul style="list-style-type: none"> ○ We should keep in touch, contribute to the knowledgebase and share the same ○ A ship visit to LNG carrier would be useful. ○ SMA could arrange for placement to LNG ships ○ SIGTTO safety guidelines should be included ○ Boiler manufacturing techniques should be included ○ High voltage distribution system found in LNG ship should be included ○ One month of course time is too short
++ These are all international students.	

Table I. Feedback to Improve Learning

From above that, it can be said that this new way of learning was quite acceptable to this mature group of students. However, at the beginning of the module a few of the students were worried about the adequacy of their computer knowledge. It was also found that the younger learners were more comfortable in using CmapTools and ExamView software. Hence, their contributions to the knowledgebase were more than the older members of the cohort.

CONCLUSION

The paper described a case study undertaken at the SMA to implement a flexible-learning student-centred methodology of computer-mediated learning. The experience gained in using a new model of learning based on development of learning objects, resource-based learning and integrated, on-demand online assessments were also described. The student feedback was generally positive.

The results obtained from the case study suggest the need for further educational research to substantiate the claims for using this model as a viable way of learning in maritime education.

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