Interactive Teaching of Military-Technology - a pilot study of implementation

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***Abstract*—The interactive learning platform CompEdu, developed and used since 1997 at the Division of Heat and Power Technology at the Royal Institute of Technology , has recently been introduced as a new tool for teaching Military-Technology at the Swedish National Defence College. In this pilot study, interactive teaching has been tested at the initial training of junior officers at the Swedish National Defence College. Results from a student evaluation of the tool are presented and these results will be incorporated in future implementations of this interactive teaching method on a broader scale in Military-Technology. The students appreciated the freedom of being able to choose when and where to study the pensum and found CompEdu being an excellent tool for facilitating reviewing the chapter before an exam. An outline for future work is presented.**

***Index Terms*—Interactive teaching, eLearning, Military-Technology**

I. Introduction

Previously, teaching in Military-Technology at the Swedish National Defence College (SNDC) had an emphasis on how different technology functioned in a great variety of military systems. However, the important issue of how the technological systems affected military operations was not adequately treated and the relevance of the military technology teaching towards the future profession of the officers was considered to be poor.

The subject of Military-Technology was redefined at the SNDC in 2003 as being "the field of science which describes and explains how technology inflicts on military matters at all levels and how the profession of military officers influences and is being influenced by technology" [1]. There is a deliberately put hyphen between the two words military and technology to emphasize that they are linked and that they form one word, having a different meaning than the two words standing separately. Military-Technology is based on several different subject areas from different disciplines and combines understanding of the military profession deriving from social science with the foundations of natural science and with superstructure and dynamics supplied by engineering [2]. Military-Technology deals with matters which ultimately have to do with an officer's ability to carry out his profession. The officer must be able to use technology as a tool of war as technology by itself cannot solve any military problems [3]. Thus teaching of Military-Technology at present has an emphasis on possibilities and constraints that different technologies offer in military operations, which is a clear change of focus compared to the period before 2003.

We now take the next step in the process of transforming the Military-Technology teaching by gathering the available learning material used at the division of Military-Technology at SNDC, digital versions of the textbook series on Military-Technology developed at SNDC, as well as scientific Military-Technology articles produced at SNDC into a dedicated Military-Technology bookshelf in the interactive learning platform, CompEdu.

A. The interactive learning platform CompEdu

The interactive learning platform CompEdu, developed and used since 1997 at the Division of Heat and Power Technology at the Royal Institute of Technology (KTH) was presented in [4]. The platform contains different books and chapters where theoretical sections, a significant number of related interactive simulations, movies, animations and realistic case studies are included. Significant background information related to historical development in the field, a display of existing components, nomenclature as well as questions for self-assessment and examination, enhance the learning process in a significant way [4].

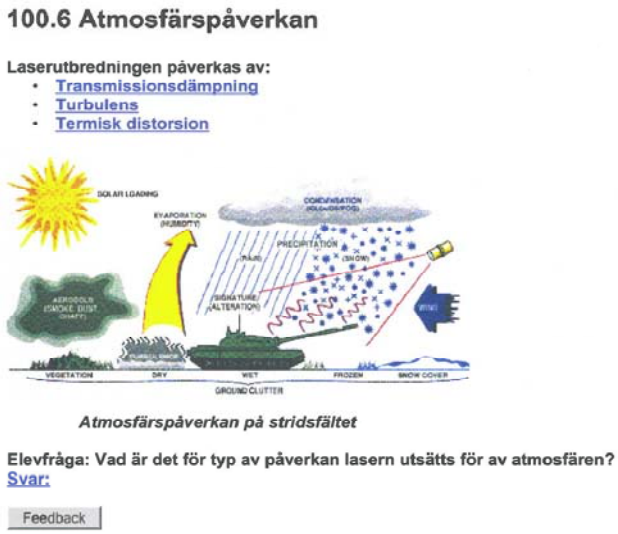

Figure 1. An example of a page in CompEdu, showing the blue pop-up links.

In traditional classical classroom teaching the students are expected to grasp the full implications of the shown material immediately. With the CompEdu platform the students have a possibility to study the chapter at any time from any computer connected to the internet. The student may study the material over and over at their own learning pace and use the self-assessment tool when preparing for an examination to find out which areas of knowledge they have to revisit.

Particular attention has been paid to structure the information aiming at more coherence and to enhance interactivity. Firstly, the complete material is organized as a "bookcase": a shelf gathers the information about a general subject, which is divided into books, which are divided into chapters. Secondly, all the chapters share the same build-up: the first page in each chapter gives an introduction, the second one defines which knowledge the student has to acquire and the last one sums up the key points. The main text is limited to keywords or short sentences, but a lot of supplementary information is available as "pop-ups" by clicking on linked, underlined blue words [4]. With this technique the student can "zoom-in" and "zoom-out" from an overview level to learn more details about specific topics.

The teacher can easily create a power-point lecture using material from different books or chapters available in the learning platform by simply introducing a hyperlink to a specific page in the database. This facilitates lecture preparation once the material is available in the learning platform.

B. The Military-Technology shelf in CompEdu

The Military-Technology shelf, when fully implemented, will follow the Military-Technology textbook series structure with books covering the following subjects:

- Basics of Military-Technology,
- Sensors,
- Technology in support of Command and Control,
- Weapons and Protection Technology,
- Platform technology and
- Systems Engineering.

Furthermore, there will be a book containing scientific articles produced at the division of Military-Technology at SNDC, as well as a book with student papers in Military-Technology.

At present, the shelf contains books of Laser technology and Electro-optical Systems, chapters on Warheads, Material Science, Mobility of Combat Vehicles, Protection of Military Platforms and High Power Microwaves. When fully implemented, the learning platform will be able to support interactive learning in Military-Technology at all levels from initial training of junior officers to advances courses aiming at a Masters degree in Military-Technology. In the learning material the student can watch video sequences that explain specific topics. After having gone through a chapter, the student makes a self-assesment test with questions covering the material the student has to master as well as questions that might appear in an examination. Immediate feedback is given by indicating a correct or a wrong answer.

The aim of introducing an interactive session with CompEdu at the very beginning of each course is not to replace the teacher but to make the time spent with the teachers more effective since the students have a more unified, and hopefully, higher level of understanding of the subject when the teacher led lesson starts. This means that the increases the possibility for more profound discussions with the teacher and between the students. Hence, more time is available for synthesis, analysis and discussions aiming at higher levels of understanding and military usefulness according to the Eliasson-Norsell Model [5].

II. Experiences From a Pilot Study

A. Pilot Study with Junior Officers Using CompEdu

In the fall of 2009 a pilot study was performed at the SNDC where a group of 16 junior officers following a course in sensor technology used the interactive learning tool CompEdu to study fundamentals of laser technology. The students spent 50-100% extra time on the interactive session including self assessment, compared to a traditional lesson. Before and after the interactive session, the students had to perform a knowledge test in order to analyze if the students average knowledge in the subject was changed by the interactive session. The knowledge test consisted of 19 multiple-choice questions with a possibility of attaining 32 points if all questions were correctly answered. The results from the knowledge test are presented in Table I. It can be seen that the mean value of individual results incremented from 19 to 28, which is a considerable enhancement. It could of course be argued that using the same questionnaire after the interactive session as before, might affect the result since the students recognize the questions. For future evaluation we consider using different questions before and after the interactive session.

An other experience from this evaluation is that it should have been very interesting to compare the learning effect obtained with another group of students using the same knowledge test before and after a traditionally performed classroom session. Then it may have been possible to evaluate if there is any significant difference in how efficiently the two methods contribute to the knowledge of the students.

In connection to the knowledge test the students also had to answer a few questions about their use of the interactive learning tool, which will be presented in the following paragraphs.

B. How the students experienced learning with the tool

A majority of students found this way of studying to be a good complement to traditional teaching; however they did not want the method to replace traditional teaching since they would like to be able to ask questions to the teacher on the parts they did not understand.

TABLE I.
Results of Knowledge Test Before and After Interactive Session

	Min	Max	Mean
Result before interactive session	13	27	19
Result after interactive session	19	32	28

TABLE II.
THE STUDENTS OPINIONS OF INTERACTIVE TEACHING

Advantages	Disadvantages
You can chose where to study	No teacher to ask
Working in groups of two students reinforces learning	You need a connection to internet, which you might not have everywhere
You can study at your own speed	The material must be extensive in order to avoid remaining questions
You can focus on the parts you have not understood	The student must have academic ability and discipline
You can choose when to study	It puts high requirements on the learning material
The self-assessment indicates how much you have learned	There is a risk that you learn by heart without properly understanding
The method stimulates learning	The learning material must be temping
You can easily review the material before an examination	
This active learning process provides faster learning	

The main advantage was found to be that the students could study at their own learning pace. The students thought that the chapter had a good structure which made it easy to get an overview of what they were supposed to know after having worked with the material.

The students found it to be easy to use the pop-up links to go deeper into specific details that needed explanation.

Some students thought that this interactive method was an efficient way of learning and stated that it was easy to keep a focus on what they should learn while some students thought it was difficult to concentrate using the interactive method in the classroom with all the other students around.

Many students anticipated that the tool would be a good help when reviewing the material before the examination and thought that interactive teaching should be implemented on a broader scale in education at the SNDC.

C. Student opinions of advantages and disadvantages with interactive teaching

In Table II the opinions of the students concerning advantages and disadvantages with the interactive teaching method are summarized. These experiences will be utilized when new learning material is produced and will be discussed in section III.

D. Student suggestions for improvements of the learning material

The students suggested the following improvements of the learning material:

- More references to literature and internet links to sites where more information can be found is required
- More extensive explanations in figure captions
- More videos, animations and interactive simulations
- Some used terms need an explanation
- A better graphical design is desired
- A structure that tells you how much of the material you have gone through and how much that remains
- More self-assessment questions
- Self-assessment multiple-choice questions run the risk of leading to superficial learning
- More distinct and legible figures

The majority of these suggestions, if viable, can easily be taken care of in the continuous process of improving the learning material and must be kept in mind when new interactive learning material is produced.

E. Student views about interactive learning at home

Two thirds of the group would like interactive learning at home to be one of the learning methods used at SNDC. The purpose should be to acquire a basic knowledge of the subject in order to be able to discuss possibilities and limitations of military applications of the subject at a teacher led seminar, where they also can ask questions on the parts they did not understand. At the seminar there should also be time for demonstration of basic principles and equipment. One way of giving the students support during their interactive studies is to schedule a "question/answer" session in stead of "classical lecturing". It is also possible to encourage the students to send in their questions to the teacher by mail or face book as an alternative to the "question/answer" session.

One third of the students did not want to replace traditional classroom education with interactive home studies because they value the dialogue and discussions that take place in the classroom which leads to, in their opinion, a more thorough understanding of the subject.

Many students find the interactive learning tool to be an excellent learning aid in the preparation for the examination. Some of the students would appreciate a combination of home studies and classroom teaching.

Home studies with this method would, according to the students, be even better if the teacher could be available on telephone and email to answer their questions while they study.

F. Will the acquired knowledge be remembered for a longer time with interactive learning?

Two thirds of the students believe that the knowledge will be remembered longer with interactive learning than with traditional classroom teaching. They state that the student takes a more active responsibility for their learning with this method. On the other hand, one third of the students think this method leads to superficial learning which will be forgotten faster than traditional teaching.

One possible way of trying to get the knowledge to last even longer is to let students work together in groups of two with the interactive learning material and explaining difficult parts to each other. Furthermore, in the self assessment section there is an "open-ended questions" part where the students are expected to send in their extensive answers to the instructor by email and subsequently getting written feedback. These learning activities are believed to contribute to the students remembering the acquired knowledge for a longer time.

III. DISCUSSION

Given that this is the first time interactive learning has been tested within the courses in Military-Technology at the SNDC the student opinions of using this method were surprisingly positive. This is very much thanks to the experience and support that has been given from the

division of Heat and Power Technology at KTH. The here presented student opinions and suggestions for improvements will be implemented before the next time the interactive tool is used in education.

The next time the course Weapons and Protection Technology is given at the initial training of junior officers, all learning material for different subtopics will be available on CompEdu. The course will be given the following structure: After an introductory lecture in each subtopic, the students will be instructed to study the interactive learning material on their own and go through the self assessment questions before the next lecture. That lecture will give the students an opportunity to ask questions on issues they did not fully understand on their own. The teacher can also make some experiments and present equipment used in the Armed Forces. Since the number of students at the junior officer training is increasing, teaching has to be performed in eight classes in sequence. This is a very expensive form of education. If the students could learn the fundamentals of each subject using the interactive tool, a smaller number of teacher led seminars could be held starting from a much higher average knowledge base which is expected to bring the discussions in the classroom to a higher educational level. The time in the classroom could then be efficiently spent on discussions of how different technologies inflicts on military matters, e.g. tactics and operational planning, i.e. the essence of Military-Technology according to our new definition. We also plan to introduce a series of seminars where the different subtopics in the course interact on a higher system level, e.g. comparing the effect of different weapon systems on typical platforms such as a fighter aircraft, a surface attack ship and an armour fighting vehicle and discuss efficiency and limitations of appropriate protection measures.

An extensive student evaluation will be made after this course in order to further improve the course for the future. For some student groups we intend to make a comparison between interactive and traditional teaching in order to see if there is any difference in the learning efficiency of the two methods.

Initially we anticipated that this new teaching methodology would decrease the work load for the teachers. We now realize that transforming power-point lectures to learning material in CompEdu is rather time consuming. This work, however, only has to be done the first time the lecture is prepared for CompEdu and the life time for the learning material is expected to be several years. The value of bringing the students to a higher common knowledge level before classroom teaching begins and having fruitful seminar discussions leading to the goal of reaching a higher educational level than with traditional teaching however makes the effort worth it.

In the future we consider introducing video-recorded lectures as a complement to the learning material available on the CompEdu platform. The platform also supports giving lectures on-line with student participating by an internet connection at home where they are able to interrupt the lecturer with questions. This is presently used with success at the division of Heat and Power Technology at KTH.

With this new teaching philosophy we aim at achieving higher levels of understanding of Military-Technology. This also signifies our shift from quantitative to qualitative teaching.

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