Considerations about Effectiveness and Limits of Computer Based Training in Maritime Industry

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Abstract: - Maritime Education was for many years very traditional with part of the training time spent in the schools and part of it spent at sea on the job. In the last ten years a lot of computer applications have appeared on the market with the intention of replacing or at least reducing the time spent at sea. The purpose of this paper is evaluate the positive and negative impact of CBT on Maritime Education and Training (MET).

Key-Words: - CBT, MET, ship, education, maritime, simulator

1 Introduction

The use of computer-based training (CBT) has been increasing over the past few decades. In that time-span incredible advances have been made in computer technology and its availability at relatively low prices has led the educational service to encourage the use of computers in MET institutions and at home. The rapid developments in programs allow interaction via text, graphics, voice and the most recent developments in microcomputer technology provide even greater power and ease of use through advanced visual and auditory devices (Alessi & Trollip, 1991).

In addition, the ability to combine a wide variety of multimedia content is a great advantage to increasing retention of new knowledge. Today’s multimedia capable PCs allow developers to take advantage of the fact that people, as educational research indicates, learn 20% of what they see, 40% of what they see and hear, and 70% of what they see, hear, and do (Muirhead, 2000).

CBT in the maritime field is defined by Nautical Institute as a broad generic term used to describe how computer-run software can be used in support of training applications. These may include initial training or for imparting or reinforcing underpinning knowledge. Use of computers for the initial training in the maritime industry it is a bit questionable since most of the trainees have only seen a ship in the pictures and movies and no matter how powerful is the soft it can not replace a field trip.

2 Types of CBT used in the maritime industry

2.1 Textbooks as CBT
Textbook or written class material can be replaced by online documentation, available on disk or downloaded from the Internet. A distinct advantage of delivering educational material this way is reduced costs. Textbooks can be very expensive. Online documents can look just like the hardcopy document, but they can also include hyperlinks and jumps.

A major disadvantage of providing class material this way is the difficulty in reading extensive material off the computer monitor.

2.2 Computer based knowledge management
“Knowledge management, a sister discipline to training can provide a total picture of the learning curriculum, provide true orientation of the trainee to the learning material and connect the trainee’s vocational activities to reference information that cannot be memorized easily” (Lyras, 2000, p. 42). This issue is very important for the people working on board ships as internet is not always available and some information may be urgently required. That is the main reason why a good knowledge
management system is very important for shipping companies.

2.3 Computer Simulation

Today there are a significant number of computer simulation applications available on the market and for computer simulators the most important factors are reliability and the trust people put in computer simulations. It depends on the validity of the simulation model, therefore verification and validation are of crucial importance in the development of computer simulations. Another important aspect of computer simulations is that of reproducibility of the results, meaning that a simulation model should not provide a different answer for each execution. Although this might seem obvious, this is a special point of attention in stochastic simulations, where random numbers should actually be semi-random numbers.

Computer graphics can be used to display the results of a computer simulation. Animations can be used to experience a simulation in real-time e.g. in training simulations. In some cases animations may also be useful in faster than real-time or even slower than real-time modes. Furthermore, simulation results are often aggregated into static images using various ways of scientific visualization.

Complex simulators for navigation and ship’s handling are in common place nowadays and up to a certain extent they can be used to reduce the minimum required sea training for graduates of maritime universities, but in no case they can replace sea training. The main short coming of the simulation activity is that it is impossible to create the real life environment, stress, fatigue and fear that may sometimes be encountered in the emergency situations on board.

2.4 CBT in Distance Learning

Today the concept of distance education is fairly well-understood, and the potential importance of distance education in the future of education is also generally acknowledged. With advances in multimedia and communication technologies, distance education is being adopted by companies as well as universities. Almost all distance learning education programs have replaced text books with CBT applications delivered either on CDs or via E-mail. Distance learning has a great potential for development in the maritime industry as most of the seafarers look for a future job on shore. The main barrier against development of distance education in the shipping industry is the increased workload which is in common place on almost all type of ships.

3. Real world approach: Case study about quizzes result in CMU Virtual Learning Center

During time, for large scale e-learning deployments in maritime educations (since 2001 period and about 5500 users base in CMU) we can make several considerations about this subject.

Online CBT – COLREG Testing Facility samples – CMU 2009

<table>
<thead>
<tr>
<th>Question/Answer type</th>
<th>Question text</th>
<th>Answer’s text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1A1</td>
<td>How shall 2 sailing vessels maneuver when they are approaching one another, so as to involve risk of collision and each has the wind on a different side?</td>
<td>The vessel which has the wind on the port side shall keep out of the way of the other.</td>
</tr>
<tr>
<td>Q1A2</td>
<td></td>
<td>The vessel which has the wind on the starboard side shall keep out of the way of the other.</td>
</tr>
<tr>
<td>Q1A3</td>
<td></td>
<td>The vessel which has the wind from astern shall keep out of the way of the other.</td>
</tr>
</tbody>
</table>

Table 1. Question analysis hypothesis

<table>
<thead>
<tr>
<th>Q/A Type</th>
<th>partial credit</th>
<th>R Counts</th>
<th>R %</th>
<th>% Correct Facility</th>
<th>Standard Deviation (SD)</th>
<th>Disc. Index (DI)</th>
<th>Disc. Coeff. (DC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1A1</td>
<td>(1,00)</td>
<td>59/144</td>
<td>41%</td>
<td>41%</td>
<td>0,493</td>
<td>0,69</td>
<td>0,55</td>
</tr>
<tr>
<td>Q1A2</td>
<td>(0,00)</td>
<td>55/144</td>
<td>38%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1A3</td>
<td>(0,00)</td>
<td>8/144</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Q/A statistics

Where this table presents processed quiz data in a way suitable for analyzing and judging the performance of each question for the function of assessment. The statistical parameters used are calculated as explained by classical test theory.

Facility Index (% Correct)

This is a measure of how easy or difficult is a question for quiz-takers. It is calculated as:

\[
FI = \frac{X_{\text{average}}}{X_{\text{max}}}
\]

where \(X_{\text{average}}\) is the mean credit obtained by all users
attempting the item, and $X_{\text{max}}$ is the maximum credit achievable for that item.

If questions can be distributed dichotomically into correct / incorrect categories, this parameter coincides with the percentage of users that answer the question correctly.

**Standard Deviation (SD)**

This parameter measures the spread of answers in the response population. If all users answers the same, then SD=0. SD is calculated as the statistical standard deviation for the sample of fractional scores (achieved/maximum) at each particular question.

**Discrimination Index (DI)**

This provides a rough indicator of the performance of each item to separate proficient vs. less-proficient users. This parameter is calculated by first dividing learners into thirds based on the overall score in the quiz. Then the average score at the analyzed item is calculated for the groups of top and bottom performers, and the average scored substracted. The mathematical expression is:

$$DI = (X_{\text{top}} - X_{\text{bottom}})/ N$$

where $X_{\text{top}}$ is the sum of the fractional credit (achieved/maximum) obtained at this item by the 1/3 of users having the highest grades in the whole quiz (i.e. number of correct responses in this group), and $X_{\text{bottom}}$ is the analog sum for users with the lower 1/3 grades for the whole quiz.

This parameter can take values between +1 and -1. If the index goes below 0.0 it means that more of the weaker learners got the item right than the stronger learners. Such items should be discarded as worthless. In fact, they reduce the accuracy of the overall score for the quiz.

**Discrimination Coefficient (DC)**

This is another measure of the separating power of the item to distinguish proficient from weak learners. The discrimination coefficient is a correlation coefficient between scores at the item and at the whole quiz. Here it is calculated as

$$DC = \frac{\text{Sum}(xy)}{(N \cdot s_x \cdot s_y)}$$

where Sum(xy) is the sum of the products of deviations for item scores and overall quiz scores, N is the number of responses given to this question $s_x$ is the standard deviation of fractional scores for this question and, $s_y$ is the standard deviation of scores at the quiz as a whole.

Again, this parameter can take values between +1 and -1. Positive values indicate items that do discriminate proficient learners, whereas negative indices mark items that are answered best by those with lowest grades. Items with negative DC are answered incorrectly by the seasoned learners and thus they are actually a penalty against the most proficient learners. Those items should be avoided. Note that, if all learners get exactly the same score for this question, then $s_y$ is zero, and DC will be undefined. This is indicated as DC = -999.00. The advantage of Discrimination Coefficient vs. Discrimination Index is that the former uses information from the whole population of learners, not just the extreme upper and lower thirds. Thus, this parameter may be more sensitive to detect item performance.

**Category aggregation issue**

From drop-down menu you can choose the aggregation strategy that will be used to calculate each participant's overall grade for this category. The different options are explained below. The grades are first converted to percentage values (interval from 0 to 1, this is called normalisation), then aggregated using one of the functions below and finally converted to the associated category item's range (between Minimum grade and Maximum grade).

![Fig. 1 Categories aggregation over three sample quizzes](image)

Important: An empty grade is simply a missing gradebook entry, and could mean different things. For example, it could be a participant who hasn't yet submitted an assignment, an assignment submission not yet graded by the teacher, or a grade that has been manually deleted by the gradebook administrator. Caution in interpreting these "empty grades" is thus advised.
Mean of grades

The sum of all grades divided by the total number of grades.
A1 70/100, A2 20/80, A3 10/10, category max 100:
\[(0.7 + 0.25 + 1.0)/3 = 0.65 \rightarrow 65/100\]

Weighted mean

Each grade item can be given a weight, which is then used in the arithmetic mean aggregation to influence the importance of each item in the overall mean.
A1 70/100 weight 10, A2 20/80 weight 5, A3 10/10 weight 3, category max 100:
\[(0.7*10 + 0.25*5 + 1.0*3)/18 = 0.625 \rightarrow 62.5/100\]

Simple weighted mean

The difference from Weighted mean is that weight is calculated as Maximum grade - Minimum grade for each item. 100 point assignment has weight 100, 10 point assignment has weight 10.
A1 70/100, A2 20/80, A3 10/10, category max 100:
\[(0.7*100 + 0.25*80 + 1.0*10)/190 = 0.526 \rightarrow 52.6/100\]

Mean of grades (with extra credits)

Arithmetic mean with a twist. An old, now unsupported aggregation strategy provided here only for backward compatibility with old activities.

Median of grades

The middle grade (or the mean of the two middle grades) when grades are arranged in order of size. The advantage over the mean is that it is not affected by outliers (grades which are uncommonly far from the mean).
A1 70/100, A2 35/50, A3 20/80, A4 10/10, A5 7/10 category max 100:
\[\text{mode}(0.7 ; 0.7 ; 0.25 ; 1.0 ; 0.7) = 0.7 \rightarrow 70/100\]

Smallest grade

The result is the smallest grade after normalisation. It is usually used in combination with Aggregate only non-empty grades.
A1 70/100, A2 20/80, A3 10/10, category max 100:
\[\text{min}(0.7 ; 0.25 ; 1.0) = 0.25 \rightarrow 25/100\]

Highest grade

The result is the highest grade after normalisation.
A1 70/100, A2 20/80, A3 10/10, category max 100:
\[\text{max}(0.7 ; 0.25 ; 1.0) = 1.0 \rightarrow 100/100\]

Mode of grades

The mode is the grade that occurs the most frequently. It is more often used for non-numerical grades. The advantage over the mean is that it is not affected by outliers (grades which are uncommonly far from the mean). However it loses its meaning once there is more than one most frequently occurring grade (only one is kept), or when all the grades are different from each other.
A1 70/100, A2 35/50, A3 20/80, A4 10/10, A5 7/10 category max 100:
\[\text{mode}(0.7 ; 0.7 ; 0.25 ; 1.0 ; 0.7) = 0.7 \rightarrow 70/100\]

Sum of grades

The sum of all grade values. Scale grades are ignored. This is the only type that does not convert the grades to percentages internally (normalisation). The Maximum grade of associated category item is calculated automatically as a sum of maximums from all aggregated items.
A1 70/100, A2 20/80, A3 10/10:
\[70 + 20 + 10 = 100/190\]

Grade items may refer to course activities (e.g. a quiz, an assignment etc.), Outcomes or even manual grades. Within a category, a grade summary is also a grade item itself. Summary grade items for a category can show up in reports, and can be used in the calculation of the grade for the parent category. For customizing purposes you can generate new grade item like in Fig. 2

\[\text{Fig. 2 Adding a new grade item as a custom concept for quiz improvements}\]
Modules that include a form of grading use the Gradebook API to generate a matching grade item, and to communicate their grades to the gradebook. The generated grade item can later be edited from within the gradebook interface.

During time, after several years of development and dozens of test and quizzes we can conclude about experimental conclusions as follows:

Main advantages of CBT in e-learning environments:
- Class work can be scheduled around personal and professional work
- Reduces travel cost and time to and from school
- Learners may have the option to select learning materials that meets their level of knowledge and interest
- Learners can study wherever they have access to a computer and Internet
- Self-paced learning modules allow learners to work at their own pace
- Flexibility to join discussions in the bulletin board threaded discussion areas at any hour, or visit with classmates and instructors remotely in chat rooms
- Different learning styles are addressed and facilitation of learning occurs through varied activities
- Development of computer and Internet skills that are transferable to other facets of learner's lives
- Successfully completing online or computer-based courses builds self-knowledge and self-confidence and encourages students to take responsibility for their learning

Disadvantages of CBT in e-learning environments.
- Unmotivated learners or those with poor study habits may fall behind
- Lack of familiar structure and routine may take getting used to
- Students may feel isolated or miss social interaction
- Instructor may not always be available on demand
- Slow or unreliable Internet connections can be frustrating
- Managing learning software can involve a learning curve
- Some courses such as traditional hands-on courses can be difficult to simulate

4. Pros and cons CBT use in the maritime industry

While the types and methods of CBT continue to grow and evolve, potential trainees should consider some identifiable factors common to all types before enrolling. While these factors are not applicable to every CBT situation, they do apply to most. After reading these pros and cons of distance education, trainees should more closely examine CBT applications that most interest them to be sure they fit their life, job and career needs.

Here are some of the benefits of CBT:

- Convenience – applications can be used whenever the trainee need them since they are as close a computer with or without internet connection;
- Flexibility - with no set class times, trainee decides when to complete the assignments and readings and in some programs can even design his own degree plan;
- Availability - CBT opportunities have exploded over the past few years, with many accredited and reputable programs;
- Cost - prices are often cheaper for CBT than for traditional education courses with no housing or meals plans to worry about;
- Time Spent in Classroom – a trainee can take a course on just about any subject without ever having to be in - or travel to - a classroom so he or she has very little wasted time. This is not always applicable in the shipping industry where a great part of the activity is based on previous experience and that is why CBT has to be followed by some special in house training;
- Accessibility - with a CBT application, a trainee can work on the course just about anywhere he or she has a computer access. In the maritime industry due to the fact that not always an internet connection is a available there may be still some problems with delivering in time of assignments;
- Better for some learners - CBT are often better for people who learn through visual cues and experiential exercises and those that require more time, are language-challenged, or introverted;
- No Interrupting Job/Career - because CBT programs are located in cyberspace or in computer's hard disk and controlled by
trainee’s pace, there is no need to quit current job or even take a leave to go to school; Here are some factors that could negatively affect the success of CBT:

- No Instructor Face Time – some trainees have a learning style that requires personalized attention from the trainers and for them most probably CBT will not work;
- Perceptions/Reputation - while slowly changing as more and more mainstream colleges and universities use CBT, there still is a stigma attached to CBT, especially in the distance education context;
- Requires New Skills/Technologies – some trainees find it difficult to work with complicated computer applications and in this case CBT is confusing them;
- No Social Interaction - while trainees often interact with classmates via email, chat rooms, or discussion groups, there are no parties or offline get-togethers;
- Making Time – for procrastinator trainees or for those people who always needs an extra push to complete work, it may be a hard time making time for their online classes;
- Little Support - trainees are expected to find their own resources for completing assignments and exams, which is empowering for some, but daunting for others;
- No Campus Atmosphere - part of the traditional college experience, of course, is the beauty of the campus, the college spirit;
- Lack of motivation – do not offer motivational factors arising from contact and competition from others;
- Lack of technical support – is one of the major limitations of using CBT on board ships due to the fact that a ship has a limited numbers of crew members.

5. Conclusions

It is a clear fact that number of CBT applications will increase in the future and only depends on trainers and trainees to identify and choose the ones that best suit the training requirements of the trainees. For trainees on board ships CBT appears to be the only alternative for personal development, but always has to be taken into consideration that in the shipping industry there is no substitute for practice and on the job training. As regards to use of CBT in the initial phase of the training it has to be used only as a complementary training to traditional training in order to be effective.

References

12 *** Moodle www.moodle.org