
Dr. ALEJANDRO LEON ARIAS
JUAN JOSÉ USABIAGA SANTAMARÍA
Ciència i Enginyeria Nàutica
Facultat de Nàutica de Barcelona
Universitat Politècnica de Catalunya
SPAIN
alex.leon@upc.edu

Abstract: - The simulators are a new technology which burst in the classrooms replacing the traditional learning way. Moreover some new technologies require of these technologies. This is the case of Dynamic Positioning courses: use of simulators is compulsory. On the other hand traditional methods to transmit knowledge (relationship between teacher and student) are suffering a deep change. This paper examines the teaching real experience between two different ways to work inside the classroom. We bring face to face the traditional learning method and the new pedagogical systems based in the taxonomies and learning through cooperation tools. At the end we validate the usage of these new tools with the newest technologies in the research of the junction between high school frameworks from the viewpoint of the education of critical thinking.

Key-Words: - Simulation; Training; STCW; Dynamic Positioning Systems; Pedagogy

1 Introduction

1.1 Dynamic Positioning Systems (DP-S)
The basic purpose of dynamic positioning of a vessel is the automatic control of the vessel position and heading. A more sophisticated definition is to maintain variations in vessel position and heading within acceptable limits, while achieving minimum thruster activity. Summarizing the DP systems are computerized systems enabling the automatic position and heading control of a vessel. To operate with such type of vessel require a certification with a double course.

1.2 General DP Operator (DPO) training scheme
There are two courses within the training scheme, the Basic course and the Advanced course. Both these courses are 4 days in duration and they contain a minimum of 24 hours of personalised tuition. The courses involves principally simulated DP operations including errors, faults and failures giving the participants the opportunity to apply the lessons learnt in both the Basic course and the seagoing DP familiarisation. Basic and Advanced course involves both theory and practice on a simulated DP system and must to cover the following topics:

- Principles of DP
- Elements of the DP system
- Practical operation of the DP system
- Position reference systems
- Environment sensors and ancillary equipment
- Power generation and supply and propulsion
- DP operations
- DP alarms, warnings and emergency procedures

The Nautical Institute [1] operates the certification scheme for DP Operators, which involves not only the approval of the training centres but also the verification of evidence and the issuing of certificates. This DP Scheme enjoys reciprocal recognition with that of the Norwegian Maritime Directorate.

The general training scheme components are summarized in the flowchart [2] (see Fig.1).

In order to clarify the aim of this paper is important to fix that ideally the watchkeeping experience should be undertaken as set out in the scheme, that is the Basic immediately prior to joining the first DP vessel and the Advanced course after the completion of 30 days seagoing DP familiarisation and the associated tasks. Also there should also be at least 30 days DP watchkeeping after the completion of the Simulator course and the application for the certificate.
Again this is to reinforce, consolidate and put into practice that which has been learnt during the Advanced course. This is also the DP time during which the statement of suitability should ideally be completed, that is once the DPO trainee has completed the courses and the majority of the required DP time.

2 Barcelona DP-Centre

Barcelona DP Centre was engaged in September 2008. It is located inside the Nautical Campus which main building is the Faculty of Nautical Studies (FNB-UPC, [3]). It’s prepared as a DP Class-2 and can achieve courses with a maximum of 6 students simultaneously. The exercises development can be achieved with two DP vessels sharing at real time the same environment.

In the Barcelona DP Simulator Centre the spaces devoted to training are divided in:

- Debriefing Room, where theoretically speeches are achieved
- Operator’s Room, auxiliary room devoted to the general control
- Design Room, to design new ships and scenarios.

2.1 Technical tools

Simulator works under a Transas [4] software Navi-Trainor 4000 - Navigational Bridge / Navi-Sailor 3000. Operative DP software is Integrated Vessel Control System Navis IVCS 2000. Simulators are build on personal computers (hosts) joined in one network domain, controlled by domain controller. The simulator software is installed on the simulator server (Trainer Server), which may be any computer included in the simulator domain. The distribution of tasks among the simulators is referred to as Tasks Configuration, which is created by using the Configuration Editor and is saved on the Trainer Server. The simulator tasks are run by Router program according to the specified Task Configuration.

At the end the Barcelona Simulator Center fulfill with all the Nautical Institute basic requirements:

- Real dual redundant DPS of known manufacturer
- Creation of any training scenario, including: wind, waves and current
- Capability to setup any faults of propulsion and steering
- Capability to setup any faults of reference and navigational sensors
- Capability to setup any faults of DPS computers, controllers and power plant

2.2 Training Courses Figures

At the end of May 2010 the overall number of DP students up to 200 people. Total number of courses is about 40 courses dived following next figure:

This figure is in front of the particular experience developed in this paper.

3 Basic regulation review

The International Maritime Organization (IMO, [5]) through the Maritime Safety Committee published a Guideline for the Dynamic Positioning System Operator Training [6]. This text is supported by the MODU Code [7] and the publication “Training and Experience of Key DP Personnel” [8], text prepared
for the International Marine Contractor Association (IMCA) [9]. The Safety Committee, recalling the obligations contained in the STCW [10] Convention, as amended, and noting the importance of adequate training of DP operators and the recommendation of the Sub-Committee on Ship Design and Equipment, invited Member Governments to bring the aforementioned guidelines to the attention of the bodies concerned and apply them to the training of key DP personnel employed on dynamically positioned vessels.

The DP Master should hold, as minimum, a formal qualification, which is equivalent to an appropriate, approved, current STCW convention standard, or an OIM certificate as appropriate and hold a current DP certificate issued by the Nautical Institute [11]. Competence for navigational watches is covered by the STCW Code.

4 Training strategy

4.1 Courses
Formal training courses for DPOs have been in operation for several years. These courses are structured and approved by the Nautical Institute, which reviews, revises and audits them from time to time. The Nautical Institute works with industry and trade associations, such as IMCA, in order to collate and input current industry needs as appropriate.

In respect of all training, it is often necessary (for audits or human resource administration) to have a demonstrable record of the training completed. The IMCA DP logbook provides one useful method of doing so. Companies could also make use of computer-based records onboard and/or in human resources departments.

4.2 General strategy
General scheme strategy to achieve the purposes before said is based on binomial set: theoretical-practical lesson. An additional third step can be found if the lesson subject can incorporate a “case of study”.

5 Taxonomy

5.1 Introduction
Benjamin Bloom examined the question of how well a person knew a subject. He discovered that there were different levels of knowing [12]. In any given subject area he found that it was possible to classify how well a person knew a subject area by how that person could use the material in that area. For example, the simplest -or lowest- level of knowledge is when the person can recall and state the facts about the subject material. The second level is when the person can explain the subject material to someone else. The complete taxonomy is divided in different categories.

5.2 The Categories
Following the taxonomy idea the thinking skills grown in six different steps:

- **Knowledge**: Recall data or information.
- **Comprehension**: Understand the meaning, translation, interpolation, and interpretation of instructions and problems.
- **Application**: Use a concept in a new situation or unprompted use of an abstraction.

<table>
<thead>
<tr>
<th>Description</th>
<th>Time / minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Lesson</td>
<td>40 m</td>
</tr>
<tr>
<td>Practical achievement</td>
<td>40 m</td>
</tr>
<tr>
<td>Case of Study</td>
<td>30 m</td>
</tr>
<tr>
<td>Debriefing</td>
<td>10 m</td>
</tr>
<tr>
<td>Total:</td>
<td>120 m</td>
</tr>
</tbody>
</table>

Table 1

Fig. 3

Estimated time related with the strategy before mentioned are in the next table:
Applies what was learned in the classroom into novel situations in the work place.

- **Analysis**: Separates material or concepts into component parts so that its organizational structure may be understood.
- **Synthesis**: Builds a structure or pattern from diverse elements. Put parts together to form a whole.
- **Evaluation**: Make judgments about the value of ideas or materials.

### 5.3 Considerations

It is a complete truth that it is much easier to grade assignments based on the lower levels than on the higher levels. In fact, as you move up Bloom's Taxonomy, you will find that rubrics become more important to ensure fair, accurate, and quick grading.

In the end, it is supremely important that as trainers help our DP students become critical thinkers. Building on knowledge and helping the students begin to apply, analyze, synthesize, and evaluate is the key to helping them.

Following Ona Visockiene [13] the tasks to reach the junction between the two objectives are set:

- To prove theoretically the possibilities of the usage of taxonomy in the research of the junction from the viewpoint of the critical thinking.
- To reveal the relevance and applicability of taxonomy through the method of expert evaluation.

### 6 Basis to the experience

Critical thinking is an important and vital topic in modern education. All educators are interested in teaching critical thinking to their students [14]. Many academic departments hope that its professors and instructors will become informed about the strategy of teaching critical thinking skills, identify areas in one's courses as the proper place to emphasize and teach critical thinking, and develop and use some problems in exams that test students' critical thinking skills.

#### 6.1 Expected results

The expected results in base of abilities, attitudes and behaviors are:

- uses evidence skillfully
- organizes thoughts
- suspends judgment in the absence of sufficient evidence to support a decision
- attempts to anticipate the probable consequences of alternative actions
- understands the idea of degrees of belief
- sees similarities and analogies that are not superficially apparent
- applies problem-solving techniques
- be aware of the fact that one's understanding is always limited
- recognizes the fallibility of one's own opinions.

#### 6.2 Working teams

In order to create an environment in which cooperative learning can take place [15], three things are necessary.

1. Students need to feel safe, but also challenged
2. Groups need to be small enough that everyone can contribute
3. The task students work together on must be clearly defined.

The cooperative and collaborative learning techniques presented should help make this possible for teachers. Also, in cooperative learning small groups provide a place where:

- Learners actively participate
- Teachers become learners at times, and learners sometimes teach
- Projects and questions interest and challenge students
- Diversity is celebrated, and all contributions are valued
Students learn skills for resolving conflicts when they arise
Members draw upon their past experience and knowledge
Goals are clearly identified and used as a guide

6.3 Tools
The strategy of apply a new approach was constructed under the basis of next tools:
- Multiple-choice test, definitions
- Explain or interpret meaning from a given scenario or statement, reaction or solution to given problem
- Put a theoretical problem into practical effect
- Identify constituent parts and functions of a process or concept
- Develop procedures, design solutions, integrate methods, create teams or new approaches, write protocols
- Review strategic options or plans in terms of efficacy, perform a FMEAS analysis in relation to alternatives

7 Learning Objectives
From a methodological point of view the DP learning experience coped with the following points:
- The DP incident could result from human error, equipment failure or from any other reason.
- If an error occurs the students must to report the incident working in group and sharing the previous experiences.
- To ensure safe practice, every incident and/or operator error should be investigated and reported.
- To design the information so that all the relevant parties in the industry can use that experience to improve their operating skills, capabilities and understanding.
- Work to responsible personnel should feel able to report errors and faults without fear of adverse company or client reaction.

One way of supporting this is to use the IMCA DP incident reporting system. Relevant incident reporting forms are available from IMCA.

During the DP training session the teacher worked with the group to operate and understand the operational requirements of the vessel and the consequences of various failures in equipment of importance to DP operations such as:

- Power generation
- Power distribution
- Thruster units and associated systems
- Power management/逻辑

They should understand the need for and implement good communications between the bridge and engine control room and have comprehensive knowledge of the vessel’s operations manuals, including the FMEA [16] as currently updated, with respect to the significance of machinery redundancy. They should also have a comprehensive knowledge of the vessel's operations manuals and FMEA as currently updated with respect to the following equipment:
- Power and UPS systems
- Thruster units electrical power and sensors
- DP control system interfaces
- Power and UPS systems
- DP control system hardware
- DP control system software
- Computer functions, tests and fault finding.

8 Results
The study has an overall span of time from September 2008 to May 2010. In order to establish a comparative model where to apply the different methodology the dates, groups and number of students are that shown in the next table.

<table>
<thead>
<tr>
<th>Group</th>
<th>Dates</th>
<th>Time</th>
<th>Courses</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>09/08 to 09/09</td>
<td>12 mths</td>
<td>24</td>
<td>104</td>
</tr>
<tr>
<td>2</td>
<td>10/09 to 05/10</td>
<td>8 mths</td>
<td>13</td>
<td>76</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>37</td>
<td>180</td>
</tr>
</tbody>
</table>

It was in the second group where the taxonomic-cooperative teaching model was applied. The partials results were:

<table>
<thead>
<tr>
<th>Category</th>
<th>Behavior descriptions</th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>recall or recognise information</td>
<td>45.3</td>
<td>49.1</td>
</tr>
<tr>
<td>Comprehension</td>
<td>understand meaning, restate data in one's own words</td>
<td>55.8</td>
<td>60.9</td>
</tr>
<tr>
<td>Application</td>
<td>use or apply knowledge, put theory into DP</td>
<td>48.2</td>
<td>73.2</td>
</tr>
</tbody>
</table>
exercises, use knowledge in response to real circumstances

**Analysis**
interpret elements, organizational principles, structure, construction, internal relationships 

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>77,8</td>
<td>75,5</td>
<td></td>
</tr>
</tbody>
</table>

**Synthesis**
develop new unique, systems, models, approaches, ideas; creative thinking, operations

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>44,2</td>
<td>56,2</td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation**
assess effectiveness of whole concepts, in relation to values, outputs, efficacy, viability; critical thinking, review; judgement relating to external criteria

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>66,7</td>
<td>79,6</td>
<td></td>
</tr>
</tbody>
</table>

Table 3

Related to the operational requirements the results are contained in the following table:

### Results

<table>
<thead>
<tr>
<th>Operational requirements</th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power and UPS systems</td>
<td>40.8%</td>
<td>41.5%</td>
</tr>
<tr>
<td>Thruster units electrical power and sensors</td>
<td>45.0%</td>
<td>56.9%</td>
</tr>
<tr>
<td>DP control system interfaces</td>
<td>64.5%</td>
<td>71.2%</td>
</tr>
<tr>
<td>Power and UPS systems</td>
<td>23.4%</td>
<td>41.5%</td>
</tr>
<tr>
<td>DP control system hardware</td>
<td>52.3%</td>
<td>63.5%</td>
</tr>
<tr>
<td>DP control system software</td>
<td>69.2%</td>
<td>80.3%</td>
</tr>
<tr>
<td>Computer functions, tests and fault finding</td>
<td>57.4%</td>
<td>77.6%</td>
</tr>
</tbody>
</table>

Table 4

At last the team objectives:

### Results

<table>
<thead>
<tr>
<th>Team Objectives</th>
<th>G1</th>
<th>G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Failure</td>
<td>59.3%</td>
<td>64.6%</td>
</tr>
<tr>
<td>Report incidents</td>
<td>50.9%</td>
<td>52.4%</td>
</tr>
<tr>
<td>Sharing experiences</td>
<td>34.6%</td>
<td>67.2%</td>
</tr>
<tr>
<td>Investigation incident</td>
<td>61.3%</td>
<td>71.1%</td>
</tr>
<tr>
<td>Designing new information</td>
<td>23.6%</td>
<td>62.3%</td>
</tr>
</tbody>
</table>

Table 5

References:
[2] The completed training scheme is collected in the document:
[3] In the web of the Faculty www.fnb.upc.edu you can find more information and details related to the DP Centre.
[9] www.imca-int.com. They works through and on behalf of its members world-wide promoting offshore safety, addressing technical matters and on a variety of other issues