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TEACHING THE 'CROWN' OF MARINE ENGINEER KNOWLEDGE
Case study

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Abstract. Educating marine engineers for their future job is quite a challenge for their professors respecting the changes occurred in shipping in past few decades. In some cases the approach is still focused on teaching the facts in the same way they were taught long time ago. But today's students have changed and so has technology. Advances in educational technology are transforming the learning and teaching processes. Consequently, the education system must adjust to better accommodate the way students learn.
The method of teaching based on real practical problems (faults, failures) seems to be giving an opportunity for students to be creative, to understand a specific problem and find a solution for it. To understand the process of decision making or risk assessment presents a real challenge. The students have been working in several teams sharing the information among the members, discussing and competing. Collaborative communication and interpersonal skills of students were developed, a collaborative environment for enhancing student team working (important for 'on board' safety) was created.
Different approaches to teaching the same known things presented through the case study in this paper resulted in better student class attendances, their successful efforts and increased motivation when dealing with tasks, and finally higher exam grades.

Key words: maritime education and training, teaching marine engineers, failure diagnosis

1 INTRODUCTION

Learning the facts for 'today's students' is something that they perceive boring because there are many easily available data sources for obtaining such facts. Also, they are a 'generation of gamers' familiar with computers, and any failures a teacher might place on the computer based simulator is easily detected and solved especially by excellent students, so such an approach for them presents no challenge, and 'the best students' are expected to become good marine engineers, superintendents or future experts that are going to be able to solve the problem. Here, an opinion is that they have to be prepared for such career in a different way.

This case study is based on the current course: "Failure diagnosis" at the Faculty of Maritime Studies in Rijeka. Only one practical problem is presented. It demonstrates an example of teaching method in case of main engine starting failure during maneuvering that is not unusual to happen on board. The real situation was explained and the students were asked to detect the cause of failure. In detecting problems and finding solutions there were several checks to be done, but they had to deal with safety, time and cost (delay) restrictions.

Such a way of teaching is in accordance with theoretical teaching principles, as well as with STCW Convention (Manila 2010) requirements, modern practicing and engineering education, [1-5]. To understand the importance of such an approach it is necessary to realize that it is based on practical needs and relevant to competences required for the future marine engineer that students can recognize easily. It will encourage and motivate them to learn as well as leads to verifiable outcomes.

2 BASIC CONDITIONS

The "Failure diagnosis" course requires good background knowledge of many other disciplines (i.e. diesel engines, turbines, steam generators, auxiliary machineries, electrical, hydraulic or pneumatic systems or different on board piping systems, etc.), so it might be called "the 'crown' of marine engineer knowledge" especially taking into consideration the real on board situation where students (or 'future marine engineers') will be expected not only to detect the problems but to solve them. In many cases it cannot be done without good theoretical knowledge and 'the database of facts' they have to build during study. From the perspective of today's students, the theory and the facts can be obtained easily on the Internet, from books or instruction manuals, so they always ask for more practical issues to be included in lectures. It is often justified, but in the real situation on board, this is not always the case.

It is not to be expected that all issues regarding 'on board' failures might be covered through classroom instruction at the Faculty, but the main aspects and approaches could be taught. One of the most important aspects usually highlighted by experienced marine engineers and experts is: "there is nothing more practical than a good theoretical knowledge". So, on board problem detection and problem solving have 'to begin' and 'to end' with knowing the theory and the facts.

3 THE CONCEPT OF TEACHING METHOD

To optimize learning objectives, at the very beginning of the course, the teacher might be challenged to compromise the level of difficulty of the problem that could be assigned in accordance with the students' background knowledge, so assessment diagnostic test is a prerequisite for the success of the course.

During the lecture, the students are allowed to use any source of information they find necessary to solve the problem (books, the Internet, instruction manuals …)

The students (53 in total) were divided in teams (5-7). Each team had to elect the 'Team leader' and the 'Team leader' was allowed to select his assistant.

When teams were set up, the basic conditions were presented:

- Ship with fixed propeller under maneuvering on departure
- Propulsion – M/E: two-stroke, 6 cylinder, reversible diesel engine with T/C,

The lecture was divided into **three different levels**: basic knowledge, thorough understanding of the systems (working principles) and thorough understanding of the safety, time and cost aspects.

1. Level

Failure: **M/E Start failure**.

Teams' task: **to specify possible reasons of the failure and their indication**.

The teams were given ten minutes to discuss and specify possible reasons and their indication that upon collection of team member opinions had to be presented and explained by each team leader. All teams were invited to discuss different opinions and to question each team leader after presentation. As it was the first level that represents 'activation of background knowledge', the teacher's role is to moderate the discussion as necessary and give the feedback as a conclusion.

2. Level

Failure: **the failure of only one starting air valve on the cylinder head**.

Teams' tasks: **to explain in given situation (maneuvering): 'Is it possible to detect quickly that failure is on the one of the starting air valve?' and 'How they can be sure which one is faulty?' and 'What possible mitigation options are?'**

The teams were given fifteen minutes to discuss and express different opinions that were collected and presented by each team leader. All teams were invited to discuss different opinions and to question each team leader after presentation. As it was the second level that requires thorough understanding, the teacher's role was to moderate the discussion, to challenge the teams by asking provocative or supportive questions, and to give feedback as a conclusion.

3. Level

Failure circumstances: **safety, time and costs aspects**

Teams' tasks: **to specify: 'Who has to be informed firstly upon detection of the problem and why?', 'What should be informed about and why?', 'Which restrictions they have to be aware of?', 'What are the possible mitigating solutions and who has to make decision about what to do?', 'What is the safety procedure that has to be followed when replacing the faulty starting air valve?' and 'What is the procedure of starting air valve replacement?'**

The teams were given twenty minutes to discuss and specify opinions that were collected and presented by each team leader. All teams were invited to discuss different opinions and to question each team leader after the presentation. As it was the third level that requires thorough understanding of safety issues and time and costs restrictions, the teacher's role was to moderate the discussion, to challenge the teams by asking provocative or supportive questions, and to give feedback as a conclusion again.

4 LEARNING OUTCOMES

The first level tasks should be easily solved by teams and it represents 'the activation of background knowledge' they had to gained from other courses (marine diesel engines, marine engine simulator training, etc.). In example the students explain the causes for the failure such as:

- M/E interlock engaged – indication: interlock signal lamp (engine control room – ECR console) – (i.e. turning gear engaged, aux. air blowers not in AUTO mode, ...)
- starting air master valve failure – indication signal lamp ECR console
- starting air distributor failure – indication signal lamp ECR console
- starting air valve on the cylinder head failure – no indication on ECR console, etc.

The second level tasks require thorough understanding of working principles of the M/E. The students have to demonstrate understanding of working principles, because they have to know that (in given basic conditions with reversible engine) it is possible just to reverse the engine trying to start it in opposite direction. Doing so, the camshaft will be positioned on the other cylinder to start, and the other starting valve is to be engaged. But, before reversing the engine, the students have to check the mark on the flywheel (or on the HP pump) to detect which cylinder was at the start position when starting failure happened. If the engine was started in the opposite direction, the one detected was the failed one.

The third level tasks require thorough understanding of the safety issues and time and cost restrictions that are to be considered in such circumstances. When maneuvering the ship, before trying to reverse the engine, the Master should be informed about the failure immediately because he had to be aware of the problem regarding the M/E. The Chief engineer (C/E) has to explain where the problem is (i.e. starting air valve on cylinder No. 3) and what the possible options to solve the problem are. There are several things to be discussed among them:

- if there is a possibility for stoppage of M/E (mooring, anchoring) to replace the failed valve, the Master should inform the C/E about
- if there are tugs engaged to assist the maneuvering, there are restrictions that should be considered as: delay of ship departure, costs connected with tugs and mooring payment, possible port traffic congestions, etc.
- if the ship is in the position where there is no possibility for stoppage and replacing the failed valve, the Master should be informed that maneuvering is possible to continue but with a possibility of delay in responding to the command from the engine room (i.e. if cylinder with failed starting valve comes to the starting position again which will require reversing to turn the engine on the other position to start), as well as of the fact that if stopping during maneuvering might be avoided than ship can proceed with maneuvering and the failed valve can be replaced afterward;
- both of them (the Master and the C/E) as well as other crew members have to be aware of the possi-

ble risks if continue with maneuvering, but the Master is the one who has to decide what should be done.

The last part of the third level tasks is connected with the safety procedures that need to be followed when replacing the failed starting air valve with the spare one. The students are required to demonstrate thorough understanding of safety precautions and measures to be applied in preventing of engine starting during replacement (i.e. informing each crew member about work in progress, closing the starting air master valve and releasing the pressure in starting system, engaging the turning gear, putting the visible warning signs that engine should not be started, etc.). Also they have to demonstrate understanding of the replacement procedure (i.e. 1. dismantling of connection piping and failed starting valve, 2. cleaning the valve seat in the cylinder head, 3. testing the spare one before mounting and applying anti-seizure compounds on sealing surfaces, and 4. mounting the spare valve and connection piping). Testing of M/E is to be done after replacement.

5 METHOD BENEFITS AND OBSERVATIONS

The teaching method used in this case study is based on the real practical problem that might happen on board, so the students can realize that it is *based on their needs* and *relevant* to their future jobs, so usually they are *highly motivated*. The similarity in grouping with on board engine crew organization (Chief engineer, 2nd Engineer...) is obvious. By working in groups, 'peer to peer' *interactive* learning is achieved which is the most comfortable for the students as they are not afraid to be mistaken and corrected by the peers. Stimulating the discussion after presentation of each team leader, the learning becomes *interactive* between the groups and it *promotes reflection* and *feedback* from the peers themselves. The teacher is in a position that allows him to moderate the discussion in an appropriate way, to challenge the teams and collect findings (i.e. on the blackboard) for each level of the lecture which finally presents the *verifiable learning outcomes* and *promotes teacher's feedback* to the students for that specific lecture.

The teacher's observations also should cover the behavior of students within the team and attitudes of team leaders. It is to be noted that the students when asked to elect the team leader usually elect the best student among themselves and they are quite confident about his/her knowledge. The best students are also to be future on board leaders. But some of the elected team leaders did not want to be elected, so it seems helpful to encourage the leaders by allowing them to elect the assistants of their own choice.

The task of the leader upon presentation was also to evaluate the participation of each team member of his team when discussing and solving problems. This is a common practice and an obligation for on board leaders (i.e. 'appraisal form' at the end of the contract) which for students is especially hard to accept. They perceive such obligation as a peer evaluation. The teacher has to explain the reasons for such a decision because they are expected to be on board leaders and fair and honest evaluation is necessary. The message they are sending across is that each member of the team is equal regarding relationship within the team, but they might not participate in solving problems equally. The member of the team, who participates more than others when solving problems, expects that his/her efforts should be recognized within the group as well as by the leader. If the leader fails to do that (i.e. giving equal parts of credit to every member of the team) he/she has to be aware that there will be a member who will not be happy with the evaluation. Also, if there is a member who didn't participate at all, by giving him/her a credit for nothing, the leader sends a 'wrong message' to the team. To encourage honest evaluation, the teacher should explain the fact that if the team leader wants to improve the results, it should be started with improving the performance of the weakest member of the team. So, the role of the leader is to lead the team, to run team discussion, to assign the tasks, to motivate, to help and to raise awareness among the members that participation of each member is important if they want to obtain better results.

The students might ask the teacher to advise them in advance of the failure that will be assigned as a task during the next lecture, with the explanation that they want to be better prepared. But on board, the failure will happen without notice. So, the teacher might suggest the system that will be failed only, but not the failure itself. In some cases it might be considered 'to trade' such students request by giving them more complex failure if known system (i.e. "you are going to be better prepared, so the problem can be more complex"). Regarding complexity, the teacher should be aware that if assigned problem is too easy to solve, the students will not be so motivated. In case of a too difficult one, they will be demoralized. So, it should be just a little bit above their knowledge as a group but solvable if they function as a good team which is quite a challenging task for the teacher. In that manner the students will obtain experience of working together and collaborating, the skills so required on board.

6 CONCLUSION

It is not to be expected that all issues regarding on board failures might be covered within the course at the Faculty, but the main aspects and approaches could be taught. The students should be aware that on board problem detection and problem solving had 'to begin' and 'to end' with knowing the theory and the facts. The teacher might support that by assigning the real practical tasks (faults, failures, problems) complex enough and in such a manner that the students have to search for the information by themselves within all available sources (books, the Internet, etc.) or by holding the team discussions, when they become aware why they have to know some theory or facts.

Such a way of teaching seems to be giving an opportunity for students to be creative, to understand a specific problem and find a solution for it, to understand the process of decision making or risk assessment and this presents a real challenge. They have been working in several teams sharing the information among them, discussing and competing with each other. So, they worked in close collaboration, a skill essential for onboard safety as well.

Different approach of teaching the same known things presented through the case study in this paper resulted with better student class attendances, their successful efforts and increased motivation when being allocated a tasks, and finally their academic performance was improved.

To conclude, such an approach is not widely published, thus we were not able to compare the outcomes of other case studies. Also, there are some observations that might be considered in different conditions, but the results of this case study were too interesting and important, and worth sharing.

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