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Arquivos de Ciências do Mar

FLOATING TEACHING LABORATORY: PRACTICE AS A TEACHING QUALIFICATION

Laboratório de Ensino Flutuante: a prática como uma qualificação de ensino

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ABSTRACT

The importance of the ocean as an economic source for humanity has been standing out for decades. Ocean study is an example of multi- and interdisciplinary science that includes studies on physical, chemical, and geological variables such as ocean currents, temperature, light, salinity, dissolved nutrients, organic and inorganic particles, and studies of organisms that inhabit from its surface to the deep sea. The data used in oceanographic studies are obtained through various instruments and collection techniques. This multidisciplinarity results in the need to use a vessel as a laboratory where it is possible to integrate all those components.

Keywords: marine science, vessel, training, instruments, data.

RESUMO

A importância do oceano como fonte econômica para a humanidade vem se destacando por décadas. O estudo do oceano é um exemplo de ciência multi e interdisciplinar que inclui estudos sobre variáveis físicas, químicas e geológicas, tais como correntes oceânicas, temperatura, luz, salinidade, nutrientes dissolvidos, partículas orgânicas e inorgânicas e estudos de organismos que habitam desde a sua superfície até o mar profundo. Os dados utilizados nos estudos oceanográficos são obtidos por meio de vários instrumentos e técnicas de coleta. Essa multidisciplinaridade tem como consequência a necessidade de utilização de uma embarcação como um laboratório onde seja possível integrar todos esses componentes.

Palavras-chave: *ciências marinhas, navios, treinamento, instrumentação, dados.*

INTRODUCTION

The training of qualified professionals who will contribute to research, conservation and orderly exploitation of marine resources is an urgent need, considering that Brazil has immense reserves of natural resources. The fact that our country has 7,367 km of coastline and more than 400 coastal cities that concentrate approximately 20% of the population, increasingly needs studies aimed at identifying, monitoring, proposing, and implementing measures to mitigate and adapt to environmental impacts resulting from economic activity and disorderly occupation of these spaces.

Currently, Brazil has 46 Undergraduate Courses and 28 Postgraduate Programs in operation, which aim to train such qualified professionals in Marine Science, understood as "the area of knowledge dedicated to the production and dissemination of knowledge about the components, processes and resources of the marine environment and transition zones" (Chaves *et al*., 2007). There are 24 courses in Fisheries Engineering, 12 in Oceanography, 6 in Biological Sciences (focusing on themes related to the Science of the Sea), 3 in Aquaculture Engineering and one in Aquatic Sciences (Krug, 2012). These courses offered more than 2,200 places for new students.

In 2013, the Executive Committee for the Training of Human Resources in Marine Sciences – PPG-Mar, through the Embedded Experience Working Group, prepared a report on the lack of vessels in Marine Sciences teaching. The conclusion was that the lack of appropriate vessels compromises the ability of trained professionals to meet the current market demands (Oliveira; Gomes & Calazans, 2013).

After many meetings at the Interministerial Commission for Sea Resources (CIRM), the report was sent and analysed by the Secretariat of Higher Education (SESu) and, in 2014, the Ministry of Education authorized the construction of 4 new vessels characterized as Floating Teaching Laboratories (LEFs) to attend the practical teaching of data collection of students of courses in Marine Sciences. These Floating Laboratories were built by the Naval Industry of Ceará (INACE), being supervised by the Federal University of Rio Grande (FURG).

During the construction of the vessels, the Rectors of Universities with Marine Science Courses decided, at the headquarters of the National Association of Directors of Federal Institutions of Higher Education (Andifes), which would be the Federal Universities in each region of the country that would be responsible for coordination and management regional level of vessels, considering the presence of a coastal seaport close to interested Universities. It was agreed that: The "*Ciências do Mar I*" would be based at the Federal University of Rio Grande (FURG) to serve the 9 courses in the South Region; the "*Ciências do Mar II*" would be under the administrative responsibility of the Federal University of Maranhão (UFMA) to serve the 13 courses in the North Region; the "*Ciências do Mar III*" would be under the responsibility of the Fluminense Federal University (UFF) for 12 courses in the Southeast Region and; finally, the "*Ciências do Mar IV*" would be at the Federal University of Pernambuco (UFPE) for 12 courses in the Northeast Region.

Inside the Floating Teaching Laboratory (LEF)

To increase knowledge about the ocean, it is important to be in a certain area and collect information that allows observing aspects of the surface, the water column, and the seabed. This requires an observation platform that allows downloading instruments,

equipment, and networks to obtain information on all aspects of the marine environment (Castello & Krug, 2015).

In this context, the use of a vessel as an observation platform is essential. It cannot, however, be any vessel. It is necessary that this platform has a minimum of requirements, which consider aspects related to navigation, onboard safety, means of communication, trained crew, provision for teachers/researchers, technicians and students, fixed instrumentation, type, and number of winches to operate equipment, instruments, and networks (Calazans, 2011).

The "*Ciências do Mar*" Floating Teaching Laboratory (Figure 1) is a multifunctional vessel and was planned to meet the objective of enabling students from undergraduate and graduate courses in Marine Sciences to practice using, handling, and observing different types of equipment of routine use in abiotic and biotic data collection. Given the multidisciplinary characteristic of teaching the Marine Science courses, the instruments on board are the same in the areas of Navigation, Safety, Meteorology, Hydro-acoustic, Fishing and Data Collection in Physics, Chemistry, Geological and Marine Biology, which will allow the formation of a national database to meet specific projects for undergraduate work and for postgraduate dissertations and thesis. In addition to this objective, it is important to highlight those students from undergraduate courses in Oceanography will fulfil the 100 mandatory boarding hours.

Figure 1 – The *Ciências do Mar* Floating Teaching Laboratory

Foto: Danilo Calazans.

Main Features of LEFs:

Length: 32,0 m.
Molded Beam: 7,85 m.
Bridge: 4,30 m.
Gross Tonnage: 252 AB.
Maximum draft: 2,83 m.
Oil Tank Capacity: 49,64 m^3.

Fresh water capacity: 35,33 m^3.
Propulsion: Two diesel engines with maximum continuous power of 550 Hp.
Maximum Speed: 10 to 11 knots.
Autonomy: 10 days or 3,300 Nautical Miles.
Three Laboratories: Hydro-acoustic, Humid, and Dry which also serves as a classroom.
Hydraulic Telescopic Crane with a capacity of 750 kg and reach 10 m.
Two Hydraulic Fishing Winches for 500 m of ½" (12 mm) wire rope.
A Removable Net Drum.
A Two-Drum Starboard Oceanographic Hydraulic Winch: one for 600 m of 5/32" (3,97 mm) wire rope and one for 500 m of coaxial cable.
One Hydraulic Longline Winch for 3,000 m of 4 mm monofilament nylon rope.
Hydraulic A-Frame aft 4 m high for 3 t.
Side Hydraulic A-Frame for 750 kg.
Crew is from 8 or 9 people and another 17 or 18 people (teachers and students) extra roll.
The vessels are equipped with the following Navigation and Safety Equipment:
FURUNO NAV NET TZ 15" and 12" stern slave.
DFF3 Black Box probe for NAV NET TZ.
GPS GP-330B for NAV NET TZ.
Radar DRS6A for NAV NET TZ.
FURUNO SC-100 Satellite Compass.
FURUNO Autopilot NAVpilot 700.
FURUNO GPS GP-170 with electronic chart plotter.
MaxSea Chat mapmedia of the Brazilian coast.
FURUNO Radar M 1835.
FURUNO Sonar CH-250 Omni Directional.
FURUNO DS-80 Odometer.
RICHIE Globemaster YB 500 Magnetic Compass.
DTECTO rudder angle indicator.
DTECTO Instrument panel MCPs.
FURUNO Automatic Identification System – AIS FA-150.
SAILOR 6216 VHF radio.
SAILOR Radio SSB 6310.
IMU SMC 108 motion sensor control.
FURUNO F150BW Anemometer.
McMURDO EPIRB.
SART JOTRON transponder.

MATERIAL AND METHODS

When boarding the LEF, students receive instructions (Calazans, 2011) on how to act on board, as well as basic notions of navegation, safety, and health. A class is also given on the importance of data collection in a scientific study aboard a platform such as an Ocean Research Vessel.

1 Study area

Study area for the development of all the work in this Teaching Laboratory comprises the entire extension of the oceanic region of the Brazilian coast, with special interest in areas close to the LEF mooring base, with the outer end not exceeding the 200 m isobath.

As proposed, the data collection stations should be made in transversal perpendiculars to the coast and in intervals that can be according to the depth or in equidistant intervals from each other up to a depth of 200 m.

Navigation between one collection station and another, observations of temperature and salinity will be made with a SEA-BIRD Sea CAT 21 Thermosalinograph; the velocity of currents across the entire water column or just a specific depth range with a TELEDYNE 300 kHz RDI hull ADCP; bathymetry for the preparation of bathymetric charts in the study area and observation of patches of planktonic and nektonic organisms with a SIMRAD EK-80 Scientific echo sounder; high resolution seismic profiling with a 3.5 kHz SYQWEST BATHY-2010PC echo sounder. An EDGETECH SSS 4125 Side Scan Sonar will enable background scanning the underwater bed and identify the places of greatest interest (bottoms with mineral resources of potential scientific or economic interest) for further work. The motion sensor SMC IMU-108 extracts deviations caused by the vessel's lateral sway.

At each previously selected sampling point, students must carry out the following collections stopped at the station point:

2 Abiotic data

Temperature, salinity, depth, and OD with SEA-Bird CTD 19 plus V2, coupled or not to a SEA-BIRD 55 ECO mini rosette with 6 Niskin type 5L bottles or with a YSI ProDSS Multiparameter. Water samples at three different depths may also be collected using, on the cable of the oceanographic winch, Niskin-type 5L bottles. A Secchi Disc is used to observe the transparency and turbidity level of the water.

Bottom sediment samples will be collected with van Veen, Box Corer and Gravity Witness point samplers.

3 Collection of biological samples

Using the same operation to collect sediment with the van Veen point dredger while the vessel is stationary, most of the collected sample or another collection operation should be used to sample the in faunal benthic invertebrates.

With the vessel still stationary, vertical drags of zooplankton, a WP2 net with a mouth of 57 cm, length of approximately 2 m and 200 μm mesh, are carried out in pre-defined depth ranges, for example, from 100 to 75 m, from 75 to 50 m, from 50 to 25 m and from 25 to the surface. A simple closing mechanism needs to be used to close the net when the net reaches the lowest depth of the depth range, preventing it from continuing to filter water to the surface.

With the vessel in motion, horizontal drags of zooplankton are carried out, with the same WP2 net, but now with a torpedo-type mechanical flow meter in its mouth to measure the volume of water filtered during its journey. When trawling is carried out on the surface, the net will be close to the vessel, allowing students to follow its trajectory. In the horizontal path of the bottom, the net, equipped with a double closing mechanism and ballast, descends to the desired closed depth, a messenger is launched to open it and after the

dragging time is finished another messenger is launched to close it again, preventing the influence of the water column in the collection on its way up to the surface. The drag speed in both drags is 2-3 knots and the drag time is 5 minutes.

To collect mero and ichthyoplankton samples, oblique hauls are carried out, near the bottom, with a Bongo-type net, with two 60 cm diameter mouths and 330 μm meshes. For knowledge of filtered water volume, a TSK-type flow meter is placed on one of mouths, together with a depressor (ballast) and a RBR Duet TD datalogger to measure the path temperature and the final depth reached in the drag descent. An inclinometer to measure the cable angle during the descent of the net helps to calculate the depth reached. The cable launch is continuous up to 2 m from the bottom. The drag speed is 2-3 knots.

High mobility benthic macrofauna, or wandering, is sampled with a Petersen-type biological dredger.

The collection of demersal fishery resources is carried out on smooth bottoms, by means of trawling for a maximum of 20-30 minutes, with a shrimp otter trawl net (enough time for the net to assume its correct position on the bottom). The horizontal opening of the net is determined in each throw by the trigonometric method.

For pelagic fishing resources, trawls are carried out with a midwater net, equipped with a SIMRAD PI-50 net probe to allow the calculation of net opening and its depth at the time of trawling. In parallel, observations with the SIMRAD EK-80 scientific echo sounder and the Fishfinder FVC-1900 type probe are carried out during the entire navigation to determine the presence, distribution, and abundance of pelagic fish.

On rocky bottoms, fishing bait traps devices are used, mainly to capture decapod crustaceans and fish. These devices are released in a specific area during the cruise and collected 24 hours after their release. In the same way, the longline line with approximately 200 hooks is launched, with buoys and hooks (weights), to show the different methods for releasing and collecting surface and bottom longlines (use of hydraulic hoist for lifting). The pickup takes place at the end of the launch day.

The data collected in certain points of the Brazilian coast in this systematic way will oversee the Course that is using the vessel at the time, but it will also be necessary to structure and make available a national bank of abiotic and biological data for use in Course Completion Papers, Dissertations and Theses, as well as scientific papers with the participation of students.

RESULTS

The four vessels are already operating.

The *Ciências do Mar I* was delivered in July 2019 and has already carried out 32 trips involving 166 teachers from 7 courses in Marine Sciences in the southern region of Brazil and 377 students from these courses were on board collecting data at 256 stations and the vessel sailed 9,721 mn (Figure 2A).

The *Ciências do Mar II* was delivered in November 2019 and carried out 7 trips with 17 teachers on board and 101 students who performed 168 stations in the northern region of Brazil (Figure 2B).

Figure 2 – Students on board

The "*Ciências do Mar III*" delivered in February 2020 and is docked in Niterói and the "*Ciências do Mar IV*" docked in November 2020 at the Port of Recife and both now can board students from their regions.

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