Ten of the best educ

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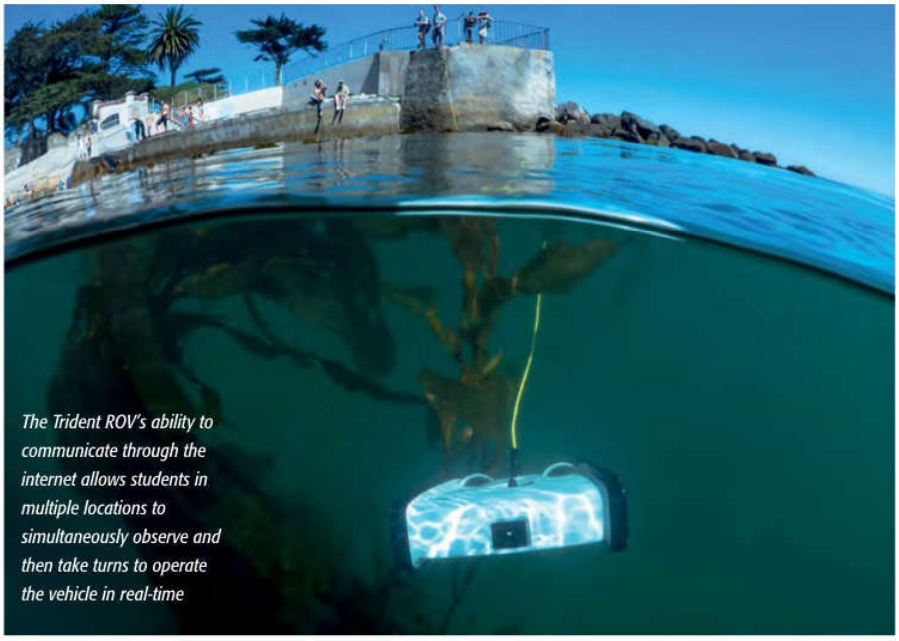
Inexpensive and attainable ROV systems can help inspire the marine scientists of the future, but which ones are the best for educational use?

Do you like to explore and learn about our world? With 71% of the Earth being covered by water, it's about time to start learning about that 71%!

Teaching basic marine biology and marine geology can be very rewarding and a lot of fun – if it's not always out of a book that is. Field trips don't always have to be limited to museums and aquariums either. You can learn about these things in real-time with a remotely operated vehicle. These high-tech tethered underwater robots can also be used to explore historical shipwrecks and other man-made objects. They all come with underwater cameras and thrusters to manoeuvre them around, but which ROVs are the best for educational use?

Five factors were used to rate the ROVs that made this list. They had to be easy to use and maintain with a low initial purchase price. That means that there had to be an option to add equipment afterward. They also had to be able to dive deep enough to explore our undersea world. That takes a certain degree of skill.

Complicated controls and finicky software bugs can keep teachers and students from enjoying hands on learning. Along with these teaching handicaps comes some ROVs with limited display functions. Poor displays can also affect teaching efficiency. A single ROV pilot inspecting an underwater pipeline may only need a simple display. If you're attempting to show a classroom full of students the dive, then more easily adaptable displays with multiple data readouts might be better suited. Then you can start adding even more readouts by adding more sensors.



The Trident ROV's ability to communicate through the internet allows students in multiple locations to simultaneously observe and then take turns to operate the vehicle in real-time

Expandability was considered instead of packaged features, because multiple features in an ROV drives up the initial cost considerably. That would skew the pricing criteria right out the roof. Expensive package deals might be great for professional ROV owners with big budgets, but an inexpensive educational ROV only needs basic manoeuvrability with a good camera to start. As the needs and budget grows, then more equipment can be added later, including longer tethers for deeper dives.

Since most marine life is found in shallow coastal waters (epipelagic zone), a good educational ROV doesn't have to dive thousands of metres deep to teach a wealth of information to students. That doesn't mean that the rated depth means nothing to a teacher either. Just as expandability allows for greater flexibility of use, so do deeper depth ratings. This is especially true for more advanced marine biology classes and exploring deeper shipwrecks. Once you get beyond 300 metres in depth though, the price starts skyrocketing again.

The cost is always a factor with schools and teachers and most other people too. The educational ROVs considered for this list were all under US$45,000 (£33,400). It's true that there are some educational ROVs in use today that are far more expensive. Institutions with budgets well over US$100,000 (£74,000) can be far choosier than other schools. Let's keep it real for most schools and give the most credit to the lowest prices. The other reality of owning an ROV is the cost to maintain it.

If you have to be a mechanical engineer, an electrical technician and a marine biologist all rolled into one with a portable workshop in tow, then not every teacher or student is going to be able to operate an ROV very often. When you think of ROV maintenance then maybe the above qualifications might not be such a bad idea when it comes to these complicated and often fussy pieces of marine technology.

ational ROVs

Ease of maintenance means having parts that can be swapped out easily and quickly without long interruptions to the dive and therefore the lesson plan.

TOP 10 COUNTDOWN

● In at number 10 is the Hydroacoustics (HAI), USA, model Proteus 500. Its 152-metre depth rating with a joystick or keypad control makes this ROV user friendly. The joystick hardware and computer software is included in the base price of about US$35,000 (£26,000). The battery life is an impressive six to eight hours. The onboard sensors include a compass, water temperature and pressure, depth gauge and a date and time readout.

Options available are a manipulator arm, sonar, more cameras, Global Positioning System (GPS) tracking, water tester, bathometry, metal thickness gauge, more lights, better video, stronger and longer tethers and a radiation detector.

● Next on the list is the Deep Trekker, Canada, model DTX2. Priced at US$26,999 (£20,000), it's a great system for underwater education. That package comes with a 150-metre tether, but the ROV is rated to 305 metres. The ROV can be manoeuvred both laterally and vertically at the same time. Other units can only move one way at a time. Battery run time is three to six hours.

Video can be upgraded with better optics and additional cameras. A laser scale is available, and a manipulator arm.

● At number eight is the Shark Marine Technologies, Inc., Canada, Barracuda. Its 300-metre depth rating with a built in Total Navigation System and three types of controllers, one being a video game controller, makes operating the vehicle easy. The external power through the tether means longer dive times without worrying about batteries going dead.

Add-on options include sonar, manipulator arm, laser scale, metal thickness gauge, topside power, navigation systems and a radiation detector.

● On the list at number seven is the Aquabotix, Australia, model Endura ROV. It comes with its own depth sensor, compass, lights, camera and leak detector. The depth rating is 300 metres. The company claims different methods of controlling its ROV with a short three-hour learning curve.

Options available are a sidescan sonar, scanning sonar, manipulator arm, environmental sensors, fish plow, water sample collector, laser scale, metal thickness gauge, GPS and satellite communications to name a few. Pricing starts at around US$17,000 (£12,600) for a base unit. It can also be rented at US$350 (£260) per day.

● Our next educational ROV is the Super GNOM developed by INDEL-Partner Ltd, Russia. The Super Gnome is priced right at about US$18,143 (£13,480) for a base unit. This model is rated to a depth of 150 metres, but it can be modified to 200 metres as an option. It comes with a compass and depth gauge standard. It has a surface power unit for extended dive times.

Some of the other options include a manipulator arm and sector-scan sonar. Also available is a camera tilt, more lights, laser scale, more cameras, ultra-short baseline (USBL) tracking and positioning system, and even a spear gun!

● The number five spot belongs to AC-CESS, UK, with its AC-ROV 100. It has a 100-metre depth rating. The company claims easy to use controls with flight assist manoeuvrability.

Options include a manipulator arm, rollers for accessing pipelines, scanning sonar, laser scale, metal thickness gauge, and a USBL tracking and positioning system. Pricing can be found at US$14,579 (£10,832).

● The Seatronics, UK, Predator II ROV is a great choice as an educational ROV. It's rated to a 300-metre depth with a topside

power supply for long-duration dives. Standard are network controls and its own diagnostic system. Basic units can start as low as US$13,000 (£9,600).

Options available through Seatronics is the SeeByte, UK, CoPilot which means even easier controls. A Teledyne BlueView, USA, M900 2D sonar is a compatible add-on. It has options for a manipulator arm, depth sensor, Teledyne RDI, USA, 600kHz Explorer Doppler velocity log (DVL) to aid in navigation, a Tritech, UK, sonar and a tooling skid or other equipment add-ons that makes this a great choice.

- It is almost inevitable that the popular VideoRay, USA, Pro 4 Plus Base has a place here, and it shows well. Its depth can reach 305 metres, and it comes with a simple to operate joystick controller. It also has surface power for extended dive time.

Options include autonomous control, GPS and Doppler positioning systems, sonar, a crawler attachment, manipulator arm, better video, water sampler, metal thickness gauge, laser scale, more cameras, and even a radiation detector. Up to 600 metres of tether can be added to increase the range, but the maximum depth will remain at 305 metres. Base price starts at US$42,000 (£31,000).

- At number two in the list is the OpenROV, USA, model Trident. It's an inexpensive choice at US$1999 (£1485) with a 100-metre tether. It can be piloted with a smartphone, tablet or game controller via Wi-Fi to the tether interface. With a 100-metre depth rating and a phenomenal top speed of two metres per second, it has surprisingly good hovering ability too.

It comes with a choice of upgrades that I'm sure you'll take full advantage of due to its low base price. The payload area under the ROV is designed for mounting multiple Wi-Fi user defined devices. No wires are used to add options.

The Trident has an ability to communicate through the internet. Students in multiple locations can simultaneously observe and then take turns operating the ROV in real-time. More advanced concepts, software and hardware are in the works in keeping with OpenROV's open-source programming and worldwide educational philosophy.

Top choice: Blue Robotics' BlueROV2

- And in at number one is Blue Robotics, USA, with its BlueROV2. It's a great choice for an entry level educational ROV, and it rates high in all individual categories. It has a low base cost of US$3432 (£2550) with a 25-metre tether, but the tether has been tested up to 1000 metres in length. Maximum depth is still rated to 100 metres in the standard model though.

Options include a longer tether, depth sensors, GPS navigation, more lighting, better video, leak sensors and sonar. This ROV along with all of the options can still come in at US$20,000 (£14,900). If you purchase the aluminium watertight enclosure and end cap, your maximum depth automatically increases to 350 metres! More hardware and software options are currently in development. Blue Robotics has open-source programming too.

Good educational ROVs can open a student's eyes to the world of marine biology and marine geology all while exploring historical artifacts too. These ROVs have to be easy to use and maintain while being able to dive deep enough to explore our underwater world. They have to be affordable to purchase with the ability to expand their functions with add-on equipment as funds and demands increase.

There were so many inexpensive ROVs that did not make the list due to little or no expandability options or with limited thrusters and controls. They're great for providing an inexpensive way to look under the water, and therefore do have some educational value. Unfortunately, that's all they are ever going to do for you.

There were also some great multipurpose ROVs that had all the capabilities needed to be number one except for the pricing. If your budget will allow for a higher end unit, then the following honourable mentions might be a good investment for a great underwater teaching experience:

- Saab Seaeye, UK, Falcon, 100 metres, US$91,000 (£67,600).
- Teledyne Seabotix, USA, vLBV300, 300 metres, US$95,000 (£70,500).

Respect our marine life while using ROVs, and teach your students to do so as well. Oh, and if you're an educator that wants to avoid some serious liability, then I recommend that you stay away from the spear gun option! Have fun learning. ■

Capt. Marc Deglinnocenti has more than 40 years of experience in the maritime industry and is a former National Sea Scout representative to the US Maritime Administration. He received a teaching credential from California State University-Sacramento, USA, which he has used to teach maritime technology to students in the California area. He writes technical maritime articles for publication in maritime journals, magazines and other periodicals.