Using Robotics Platforms to Motivate Students in Math and Science

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The main goal of this presentation is to explain how to promote and motivate math and science learning in school by using robotics platforms.

To succeed in the twenty-first-century knowledge economy, students need the ability to create, design, innovate, and think critically in order to solve complex challenges. Every young person should possess deep knowledge and strong skills in math, science, technology, and engineering—and should be excited and ready to use that knowledge in the real world. To meet this challenge, we should provide students with new tools and techniques that enable them to learn and then to practice the knowledge they have acquired. Over the past 15 years, a number of robotics kit platforms have come on the market and have introduced students to math, science, and engineering at all grade levels. The goal of this presentation is to identify innovative ideas explaining how these platforms will help and improve student learning in math and science. In the presentation, we give some examples and show how the robotics kits will help teachers introduce math and science to students in a very interesting way. We explain how this strategy will help students understand science and math, and we will give them a real-life example and application illustrating how they can benefit from science and math in their lives. The presentation will use robotics platforms to show one of the possible ways of bringing new technologies into the classroom that will engage students more and might make them more interested in math and science classes. Robotics platforms (the tools, programs, software, electronics parts, and microcontrollers that we use to design, program, install, and run machines and control them by computer instructions so that they can move, turn, sense, and do many other things) are believed to increase students' motivation in math and science by giving them hands-on practical application of the methods, theories, and lessons discussed in math and science courses.

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The idea took place about seven years ago when we were thinking about applying to the National Educational Center for Robotics. We have unprecedented initiatives in Jordan in the field of using IT video conferencing or using IT in education and training teachers to develop the skills of encouraging progress and creativity in gifted students.

We started by training teachers. The center has now trained about 1,500 teachers to deal with robotics. More than 5,000 students have benefited from this experience as well. In order to encourage students, we organized local and regional competitions and took part in competitions. We organized six national competitions in robotics and three Arab competitions in Jordan. Many of our teams participated in the international competitions in robotics. Now we are establishing the Arab Union for Robotics. Over the last few years, we have worked with more than one Arab country, including Qatar, Bahrain, Kuwait, the UAE, Palestine, Syria, Lebanon, and Saudi Arabia, as well as other countries to introduce the use of robotics to encourage students to learn science and mathematics. Robotics can be programmed to do certain missions. Robotics in education means using a number of steps in order to enable students to learn to use not only robotics, but also other sciences, as a tool.

Now we are taking four main steps in training students. The first step is the design and construction of a robot and the second is programming, in which we link the program and the design through the robotic brain or the available processor. The third step is for the student to test and evaluate the robot. In a robotics academy, as the student learns robotics, he or she will be exposed to a considerable number of mathematical and scientific theorems and concepts that are part of the center's curriculum, in such subjects as mathematics, physics, electronics, and geometry. Our experience tells us that the student must be exposed to those subjects, without which no project can be completed. Not only is the robotics practicum an example of the integration of the various subdisciplines of science, but in the process of carrying it out, the students acquire a number of skills, including time management, problem solving, creative thinking, and many others. This means that a science that is difficult to apply in the laboratory can, in the end, be understood. Still, students in, for example, a physics class who are asked to answer a question involving electronics often say, “This is not included in the course. I'm studying physics. Please ask me only questions concerning physics.” Or they may not know why they are studying physics or, for that matter, Arabic language, chemistry, sociology, or any other discipline.

At the center, it seemed as if there was an urgent need to have a special tool or program that could convince students that they have to learn more science in order to finish a product or project. However, applying our experiences over six or seven years in the field of robotics gave us numerous examples which prove that students can learn lots of things in the robotics class and improve their levels in studying mathematics and science by studying robotics. Consider, for example, a summer class in which the teacher wanted the students to learn the law of speed $v = s/t$ (speed v is equal to distance s divided by time t). Perhaps the teacher writes the law on the board and tells the students that the distance is 2 cm and the time is 2 sec. Now the teacher wants the students to apply the law to find the speed. How can the teacher present the same law to the students in a different way? Toward that end, the teacher takes the students to the lab and designs a car robot with them. Next, the students program the car to move forward for a period of time or backward to perform a special mission. After the process of programming, they will go to the fourth step in the process of applying. At this time they are enjoying integrating the car and programming it. Then the teacher asks what the speed of the car was when the students moved it forward. The programming of the car represents another way to calculate the speed of the car. The students may let the car go on and may calculate the distance it travels, and when this distance is known and the time elapsed is known, they can come up with the law of speed by themselves.

We notice that what happened in the lab is in contrast to telling the students the law. In the latter situation, the law and the solution are together on the board, whereas the second experience is a special application of the first. Therefore, the students infer the law by themselves through its application. Previously, the students did not know what the function of the speed law itself is nor how to use it, nor how important it is, nor when to use it.

In another example, the students design a robot so that it can walk both forward and backward. Then they are taught to apply a number of laws that have to do with power. In theoretical math and physics classes, where there is no application of the theorems and laws they learn, the students tend to become bored. The teacher then asks, “Why should I teach math?” But now the teacher can apply the theorem or law as an experiment in the laboratory. If we take these things into consideration then we should provide students with a joyful environment. The students will then be creative and innovative. By using the tools and equipment that are available in the school laboratory, students can observe the empirical application of the law and then can state its mathematical form. In a competition, students may then recall their experiences with mechanisms such as surface waves and surface tension in water to help them get the correct results.

In conclusion, our experiences over the last years has allowed us to discover that those of our students who apply in the laboratory laws that they learned theoretically have a better understanding of those laws and can relate them better to other scientific laws that they have learned.