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Establishing Educational Robotics Labs in Iraqi Universities

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ABSTRACT

The Iraqi universities are seeking to develop the education and catching up with the scientific progress and technological advances in the industrialized countries. One of the most important goals of education development is to graduate students capable of competition in the labour market, and participate in the society development. The Iraqi universities aimed to give the students level of experience depending on the basis of scientific knowledge to help students solve the real world problems. The universities also seek to provide education linking the individual with the environment and economic requirement. The mission of the Educational Robotics Lab. at the University of Baghdad is to provide students a rigorous, interdisciplinary learning environment focused on Science, Technology, Engineering, Mathematics (STEM), to foster the joy of discovery, and to promote a collaborative culture of innovative problem solving. STEM education plays a big role as the catalyst to meet the challenges and demands of our present and future economy.

1. INTRODUCTION

STEM education integrates concepts that are usually taught as separate subjects in different classes and emphasizes the application of knowledge to real-life situations. A lesson or unit in a STEM class is typically based around finding a solution to a real-world problem and tend to emphasize project-based learning [1]. Many STEM lessons involve building models and simulating situations. A good STEM lesson ensures that students understand the connection to the real world according to [2]:

- Science: - discover and describe a better understanding of life (What is).
- Technology: - Invent and innovate by improving the natural world.
- Engineering: - control, modify, or design materials, processes, and systems (What could be).
- Mathematics: - symbolic language for representing reality.

The educational robotics lab provides a unique opportunity for teachers to place engineering design, scientific processes, technological literacy, and mathematics in context that students find engaging and understanding.

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The Lab. Includes both physical devices, and virtual simulation software that enable faculty, students, technical staff, and researchers to improve their skills, and update their knowledge in the direction of innovation and transfer it as educators to indirect impact to Iraqi high schools.

2. The Educational Robotics Lab. Goals

The goals of University of Baghdad for establishing the educational robotics lab are:

- Bolster the innovative capacity of Iraq workforce, which is falling behind other countries that are creating higher numbers of STEM-trained individuals each year compared to Iraq.
- Boost the proficiency of all students in basic STEM knowledge. This goal is designed to improve the ability of students and workers to assess problems, employ STEM concepts, and apply creative solutions in their daily lives.
- Build an Iraq robotics team from different Iraqi schools in the ages K9-K18 to participate in the Arabic and international competitions in robotics field.

Together, these goals are intended to enhance the global competitiveness of Iraq economy and help individuals achieve economic security in their careers.

The Lab. in its initial undertaken was looking at three venues to disseminate the idea behind STEM through:

- Firstly: by training undergraduate students in the college of education for pure science /University of Baghdad, because they are the future teachers in the Iraqi high schools. The college is responsible for the generation of teachers in the ministry of education so those will be the ambassadors of new technologies and STEM education.
- Secondly: The educational robotics lab convenes workshops for the teachers and high schools students to gain acquaintance in STEM fields.
- Thirdly: The lab has a plan to gain more stakeholders acceptance of these ideas in order to flourish the concept of STEM and gain support for the work in order to extend to other customers.

3. The Educational Robotics Framework

During the work in the educational lab, there are many achievements occurred, which reflects the Iraqi STEM education framework shown in FIGURE1, these are:

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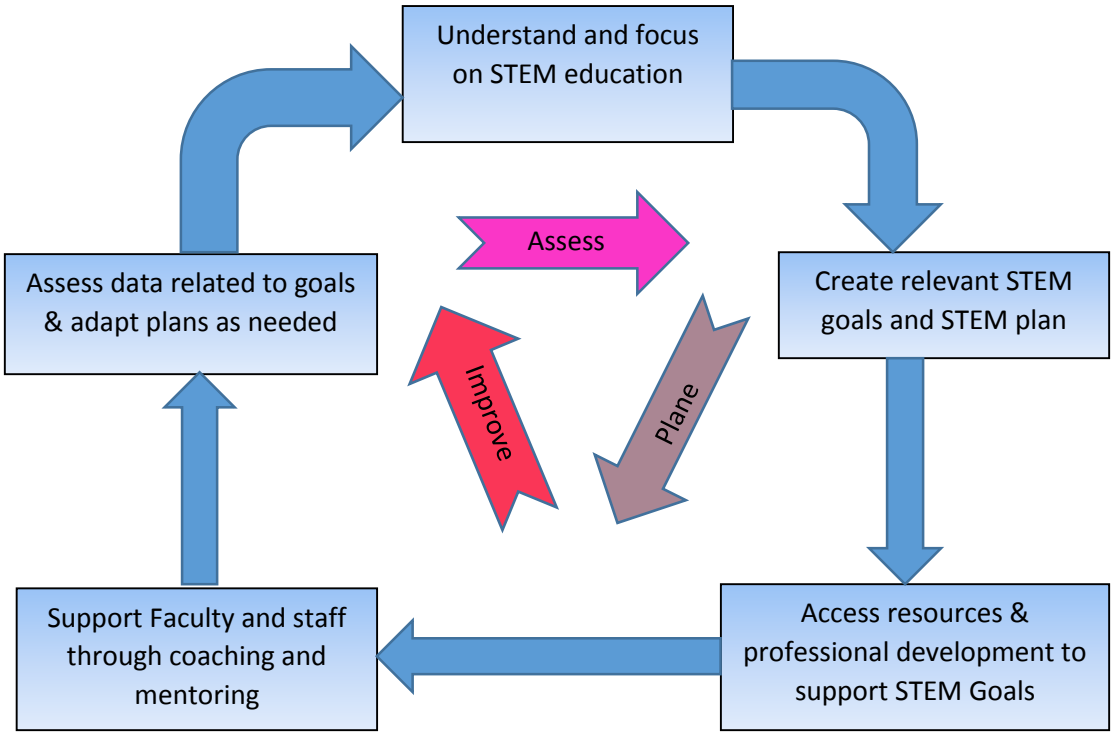

FIGURE 1. The Iraqi STEM Education Framework

- University of Baghdad established and developed educational robotics lab in the college of education for pure science to be the first lab in the Iraqi universities that accomplish STEM education.
- University of Baghdad faculty learned and practiced STEM skills and knowledge and applied them to current courses and curriculum.
- University of Baghdad/Iraq, Gannon University/ USA, and the American University of Madaba/Jordan developed an international and interdisciplinary collaborative team thereby establishing a regional partner.
- University of Baghdad/Iraq, Gannon University/ USA, and the American University of Madaba/Jordan developed and teaching a Collaborative Online International Learning(COIL) course-Practical Robotics. This course engages faculty and students from the three universities in collaborative learning and projects.

4. The Lab Activities

The lab is established to accomplish different activates that enable the college of education for pure science to be the first college implementing the STEM education concepts. These activities are:

1- The lab is stuffed with gradated students and faculty of the college of education to coordinate the different workshops, training, and researches in STEM and educational robotics.

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2- The engagement in open source community through the curriculum and training courses in practical robotics such as Arduino, Rraspberry Pi and 3D printing.

3- Design and execute a learning platform dedicated to STEM education called the Iraqi STEM Platform as shown in FIGURE 2. This is a tool that enables students and faculty to interact actively in online learning environment, and increase the community awareness in these new concept and technologies. The structure of the platform is shown in FIGURE 3.

FIGURE 2. The main page of the Iraqi STEM Platform

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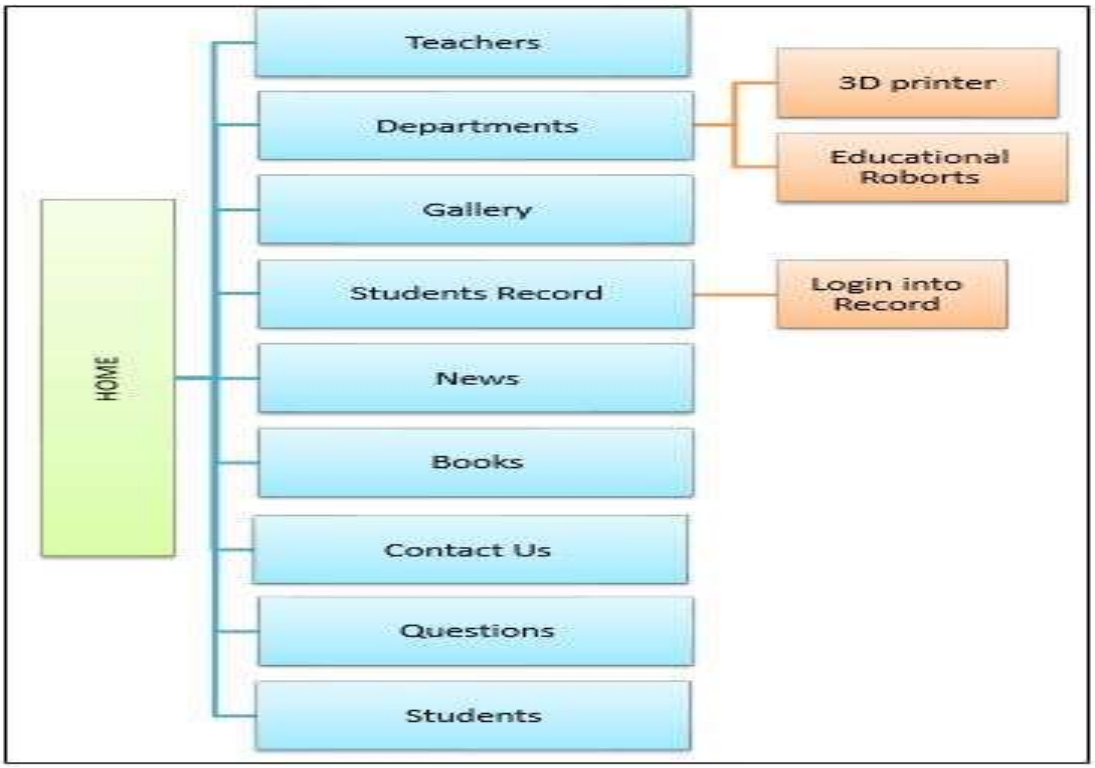

FIGURE 3. The Structure of the Iraqi STEM Platform

4- Building a team from different colleges in Baghdad University to participate in the COIL course, the team gains the skills of building robots and practices the STEM concepts through the engagement with different international universities online and in real-time environment.

4.1. The Educational Robotics Curriculum

The curriculum of the STEM courses was designed to provide the knowledge and skills in robotics field, this includes:

- The 3D printing topics: open source community delivers many H/W and S/W platform tools for 3D printing. The lab equipped with the latest technology in 3D printing which is LulzBot printers, it is one of the RipRap printers [3] that uses the fused filament fabrication (FFF) [4] technology as shown in FIGURE4. The software program used to design the 3D models is sketchup[5], and the 3D printing program is Cura[6] ,as shown in FIGURE5.

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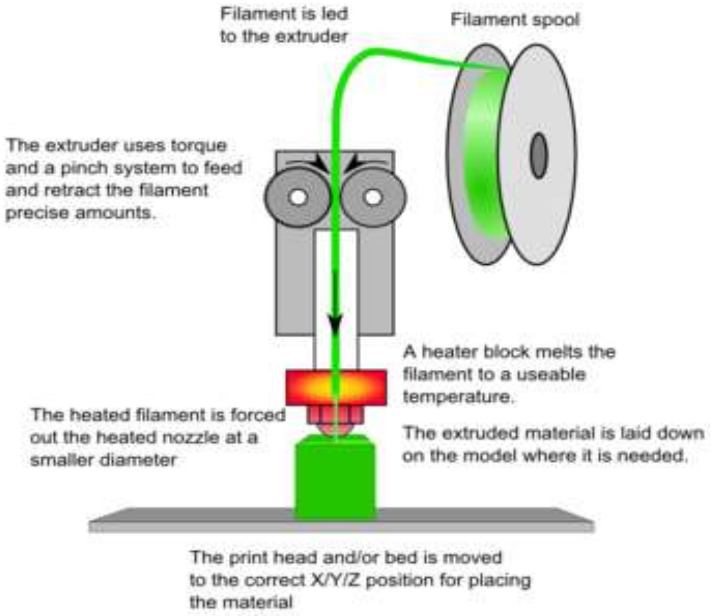

FIGURE 4. Fused Filament Fabrication

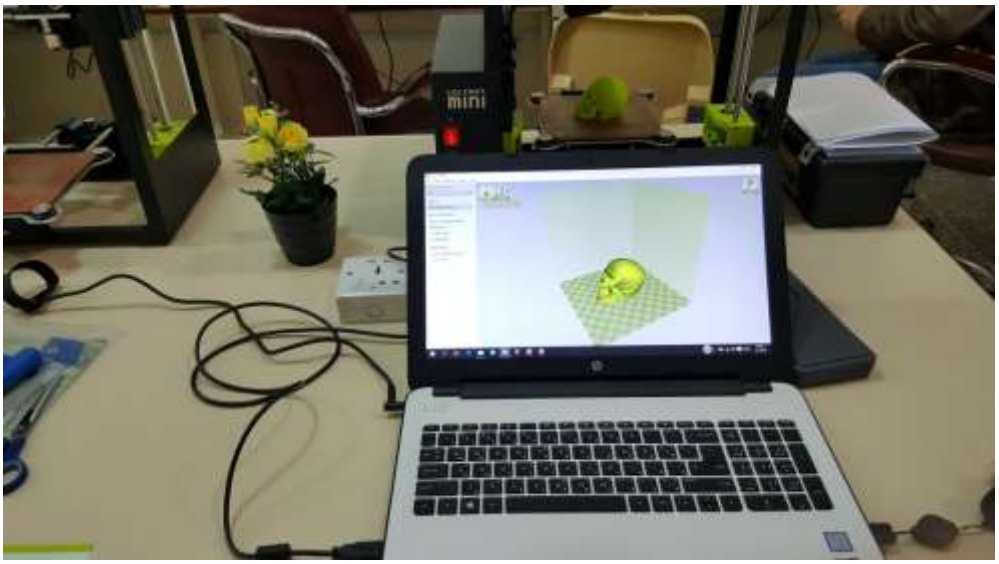

FIGURE 5. 3D printing Process

- The Arduino platform topics: It is one of the open source H/W and S/W platform which enables the students to gain skills in electronics components, electrical components like power supply and motors, sensors, actuators, and S/W C++ IDE programming skills [7], as shown in FIGURE 6.

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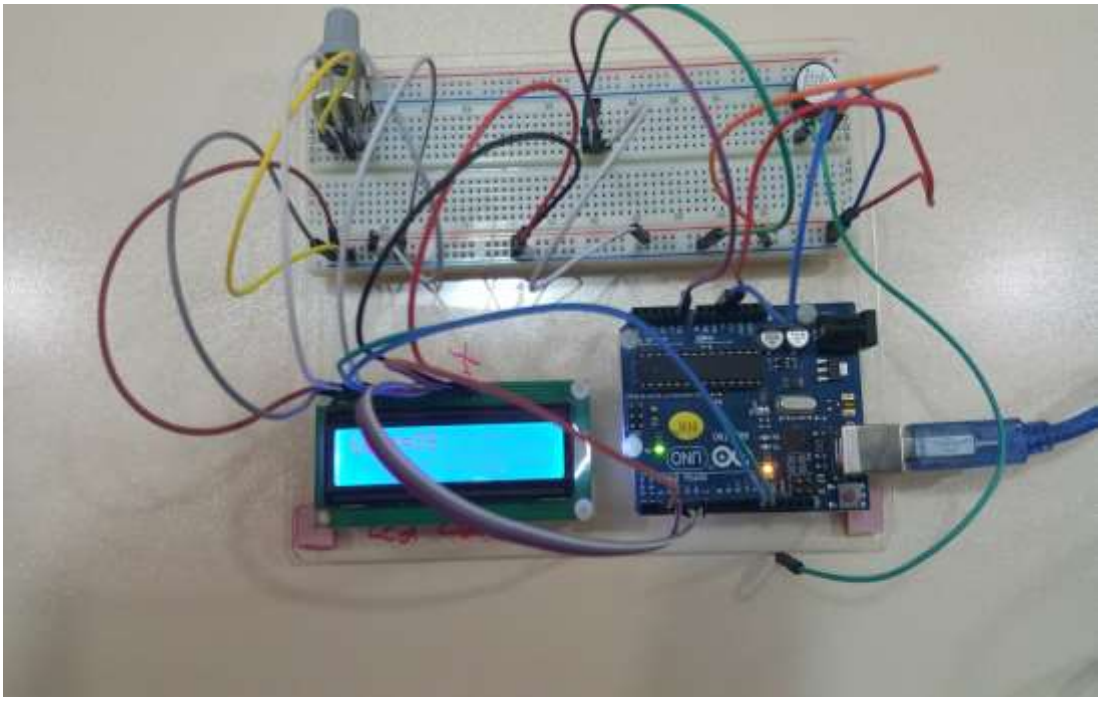

FIGURE 6. Arduino Platform

- The Raspberry Pi platform: It is another new open source platform that enables the students to gain skills in communication protocols, talking to sensors, writing code in different languages such as Python, and Java[8], FIGURE 7, illustrates different types of educational robotics implemented using Raspberry Pi 2 & 3 Model B.

FIGURE 7. Raspberry Pi Robots

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- The Software Development Platform GitHub: It is the most popular repository of the Open-Source Community's programming contributions. Even when open-source projects include non-code elements such as electrical components and/or 3D printed models, the associated program is most often uploaded to GitHub. GitHub also offers an arsenal of project management tools that allow programmers to collaborate on a project as shown in FIGURE 8. Programmers often download code from GitHub improve it and then upload the improved code back to the original code [9].

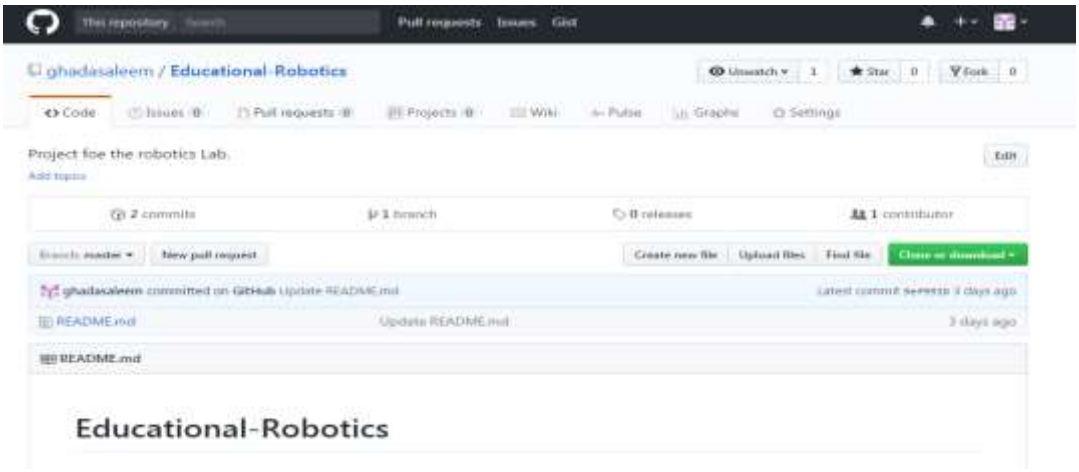

FIGURE 8. The GitHub Platform

- Practical Robotics COIL course: COIL is a teaching and learning methodology that provides innovative cost-effective internationalization strategies, fosters staff and student interaction with peers abroad, co-taught multicultural online and blended learning environments, and emphasizes experiential student collaboration.
  The practical robotics coil course is a pragmatic approach to the technical skills that fall between disciplines. This course spans topics in electrical, mechanical, computer, and software engineering and networking. Students will learn how to utilize the open-source community to find solutions. Students will learn to write programs to employ and control typical robot components including motors, servos, sensors, and cameras. Students will learn to create circuits and power systems to deploy and operate these components. Students will learn the skills to connect and communicate with robotic components using multiple communication protocols such as I2C, SPI, and UART. Students will learn IOT concepts and utilize internet protocols such as TCP, UDP, and SSH to connect and coordinate robots in close proximity and across the world. This is a Collaborative Online International Learning (COIL) Course as shown in FIGURE 9; the following table (TABLE 1) illustrates the syllabus of this course

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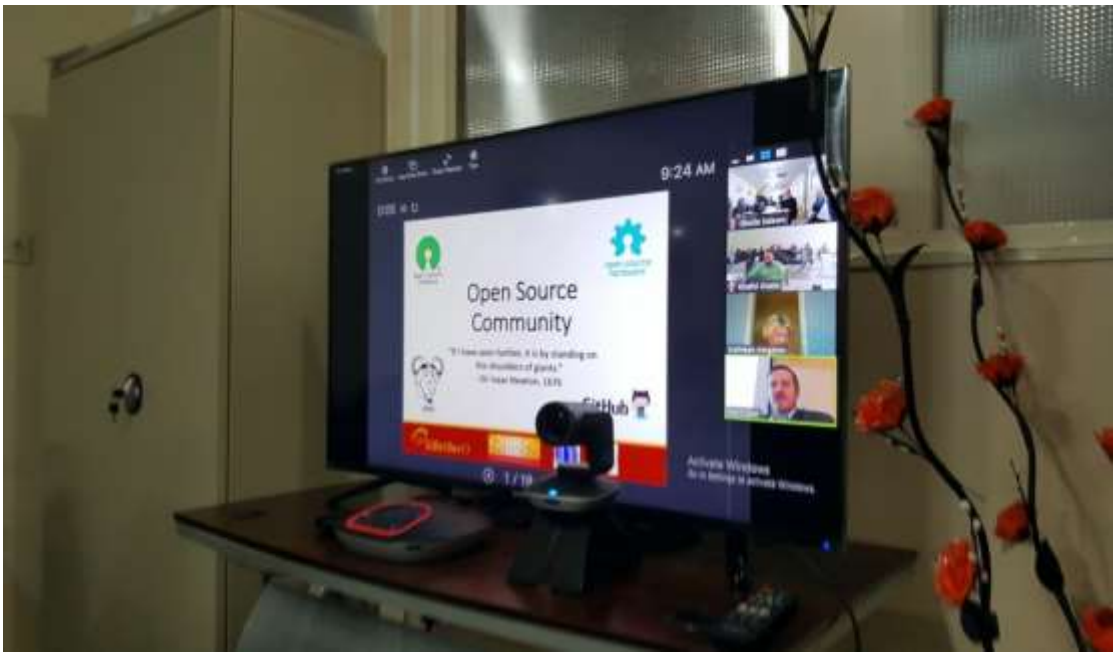

FIGURE 9. The COIL Course

TABLE 1: The Syllabus of the practical Robotics Course

Lecture	Theme	Topic
1	**Syllabus**	Overview of Course
2	**3D Printing**	Introduction
3	**Calibrating**	
4	**GCODE**	Commands and Format of GCode file
5	**3D Modeling**	Sketch Up
6	**Designing& Printing**	Printing Projects
7	**EXAM 1**	
8	**Arduino**	Quick intro + Arduino
9	**Software Dev**	Software Development Raspberry Pi
10	**Long Range Communications**	Communication Protocol
11		Connecting Across Globe
12	**Workshop**	Raspberry Pi, Netbeans, Java, Remote Platforms + Communication Protocols
13	**Videos**	
14		Introductory videos in each classroom
15	**Power Systems**	Constructing Power Circuits
16		Power Regulation
17	**Controlling Motors**	Controlling Motors Pres
18	**GitHub/HowTo**	How to contribute to OS community

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19	**Controlling Motors**	Teaching Motors to each other
20		Teaching Motors to each other
21	**Advanced Code Reading**	Register Maps and Variables
22		
23	**Control Structures and Algorithmic Problem Solving**	Manual Control
24		Artificial Control
25	**Math and Balancing**	Balancing Algorithm and PID/PIPD
26	**Math and Balancing**	
27		
28		Collaboration and Competition
	Final Exam	

5. CONCLUSION

The educational robotics lab has a vision for an innovative future that stimulates action among key stakeholder groups and that helps identify what we know currently, what needs to be discovered, and what needs to be developed to achieve the ultimate goal—creating equity of opportunity in STEM to promote lifelong learning among the Iraqi youth.

Certainly, challenges remain, but lessons can be learned and ideas for moving forward can be developed. In this process of discovery and knowledge propagation, Iraqi universities can adjust and refine the future of STEM education as new experiences and new evidence are gained, particularly about what approaches work best in certain contexts and to serve diverse learners.

The Educational Robotics lab established to be a prototype for other Iraqi universities to follow and even it is equipped with simple and open source components, this represents the importance of engaging in the open source community and enabling the students to build their own robots from scratch with low cost materials aiming to teach them the STEM concepts and enhancing their skills and abilities in this important field.

One of the important activities in the lab is the participation in the collaborative online international learning course in practical robotics with Gannon University and the American University in Madaba/Jordan. It is the first time of the lab to engage in the course which introduced also for the first time at Gannon University.

Educational robotics is a pragmatic approach to the technical skills that fall between disciplines. This will provide a unique opportunity for the universities in Iraq to reform and modernize the higher education process.

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