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# **ENTREPRENEURIAL MINDSET IN ENGINEERING EDUCATION**

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## **ABSTRACT**

*Entrepreneurship education has been there for a while in the curriculum of many business related majors and started getting into engineering curricula in many parts of the world. Entrepreneurial education for engineering graduates is vital as it places the foundation to utilize engineering technical expertise to spinout companies. In some parts of the world, like Jordan for instance, the engineering curriculum is very condensed and regulatory and accreditation bodies mandate a minimum amount of credit hours and technical discipline subjects which results in having students spend around five years to fulfil the graduation requirements. Hence leaving no room for other important subjects like business and entrepreneurship. In this paper, the authors share their experience in proposing a solution to address the lack of entrepreneurial education for engineering students. The proposed solution made entrepreneurship education mandatory through introducing it as a pre-workplacement workshop that is a graduation requirement. The workshop was available to students through two modes. The results illustrate that the proposed solution positively affected the entrepreneurial attitudes, mindset and intentions of engineering students.*

**Keywords:** Entrepreneurship Education, Engineering Students, Entrepreneurial Mindset, Entrepreneurship Intentions.

## **INTRODUCTION**

Entrepreneurial education provides students with information and knowledge they need to start their business as it helps in inspiring students to become entrepreneurs (Souitaris et al., 2007). Graduates who have studied entrepreneurship or took entrepreneurship courses have a higher probability to initiate their startups; they also have a higher intention than those who did not take entrepreneurial courses (Murugesan & Jayavelu, 2015). Entrepreneurship courses are used to be taught to management students, but recently entrepreneurship has become an

important subject in most universities and it is offered to all faculties in many universities including the engineering faculty (Menzies & Paradi, 2003; Blake Hylton et al., 2020).

It has been shown that engineering students have a high potential to become entrepreneurs and a large number of engineering students actually create their own business after graduating, they also have an entrepreneurial intention as students in the business faculty. Moreover, more engineering students nowadays are receiving entrepreneurial education (Duval-Couetil et al., 2012), however, the methods used in entrepreneurial education differs between universities and faculties, as there is no specific way of teaching entrepreneurship in the engineering faculty (Duval-Couetil et al., 2012; Blake Hylton et al., 2020). Although, the process of educating students about entrepreneurship must include theoretical and practical methods, the theoretical methods help an entrepreneur to build a base and have a background of the entrepreneurial process and ways of creating and developing a business (Abualbasal & Badran, 2019).

Engineering students are able to develop technological companies, Nevertheless, entrepreneurial programs are not distributed in all engineering faculties as it must not concentrate only on developing a business plan, it must focus on enhancing student's behavior, intention, attitudes, skills and make them aware of the entrepreneurial process (Abualbasal & Badran, 2019; Reynosa Navarro et al., 2020).

Entrepreneurship activity of engineering students contributes in creating superior startups that will help in creating jobs and enhancing the economy. Likewise, empowering engineering students for initiating technological firms is important, specifically in countries that have low level of economic growth (Maresch et al., 2016; Tretyakova et al., 2020). Among the elements that make entrepreneurship is a group of technological, informational and communicational bases that require well-trained human resources and engineering individuals who have knowledge and education about entrepreneurship (Rahman et al., 2012). Also, entrepreneurial education for engineering students, helps in changing the behaviors, building student's intention and having a positive effect towards initiating businesses as their future career (Murugesan & Jayavelu, 2015; Tretyakova et al., 2020).

Although entrepreneurship engineering education has seen rising interest by researchers and academics from all around the world despite the introductory of courses in the field here and their decades ago, the understanding of entrepreneurship engineering education is still undergoing development and the understanding of its meaning, components and pillars are continuing to evolve, improve and develop (João & Miguel Silva, 2020). Entrepreneurship engineering education integration within engineering curriculum is continuously increasing and the integration ranges from course-level to curriculum-level integration (Huang-Saad et al., 2020). LSM (Lean Startup Method) and BMC (Business Model Canvas) are very common content being introduced to engineering students (Huang-Saad et al., 2020). Other practices like joint multidisciplinary project classes and workshops target the entrepreneurial mindset through mixing engineering students with business people (Huang-Saad et al., 2020).

In this work, the authors share their experience in introducing engineering students to an entrepreneurial training embedded within their existing curriculum using two different methods over a period of more than three years and the impact it had on the entrepreneurial mindset of these students.

The rest of the paper is organized as follow. Section II reviews relevant literature. In Section III the entrepreneurial training design is presented. Section IV presents the results from

the surveyed students. The results and findings are discussed and analyzed in Section V. Finally, Section VI concludes the paper.

## LITERATURE REVIEW

Barber et al., presented a practical experience that targeted the entrepreneurial attitudes of engineering students. The study, described the efforts to create undergraduate coursework that combines competencies from engineering pedagogy with the skills-based training of entrepreneurship education. The worked combined an engineering design course taken by engineering students with business students taking an entrepreneurship course. Mixed engineering-entrepreneurship students' teams were formed to work on projects to be presented to angel investors (Barber et al., 2020).

In (Gorlewicz & Jayaram, 2020) the authors share their experience in embedding the 3Cs (Curiosity, Connections and Creating Value) of EML (Entrepreneurially Minded Learning) aligned with the KEEN (Kern Entrepreneurial Engineering Network) module into a series of three engineering courses in dynamics and control. The courses that start from a sophomore dynamics course up to senior courses showcase educators a sample of how to begin the development of the entrepreneurial attitudes of engineering students in engineering curriculum.

In other work, the researchers applied an Entrepreneurship Journey on second year students of an engineering master program, in which students are enrolled in the Entrepreneurship journey. The program ensures students' proposals for a startup are ready, avoiding high initial failure risks. The succeeded proposals were those with team members with complementary backgrounds, usually different than engineering. The authors concluded that the focus on value creation, beyond any technical solution, is clearly perceived (Martínez & Crusat, 2019).

Ciampi et al., discussed the inclusion of the “*Working with Communities*” course into the third year of an engineering program. The course provides students with the chance to work as consultants to foster an entrepreneurial community in the city. During the course, students developed skills and perception of taking risks and turning today's failure into tomorrow's success. Students gained the ability to evaluate their own performance and make adjustments (Ciampi et al., 2016).

In light of the integration of entrepreneurship education in engineering curricula, Sanchez et al. studied the impact of entrepreneurial motivations on entrepreneurial intentions among future engineers. A positive contribution of entrepreneurship mindset is supported by the understanding of the importance of the independence of future engineers on any family financial support and economy. The study also shows moderator effect in entrepreneurial training on future engineer's entrepreneurship intentions. Motivating future engineers is also achieved through showcasing successful startups, conducting workshops about idea-generation, brainstorming, business plan creation and organizing business-plan competitions (Barba-Sánchez & Atienza-Sahuquillo, 2018).

Matlay et al., evaluated entrepreneurship courses in an Italian university, and discussed the problems and the future opportunities of entrepreneurship education. The main problems of entrepreneurship education are the limited number of entrepreneurship courses offered by Italian universities due to the centralization of the higher education system, the teaching method, and the few numbers of academics who are specialized in the topic with lack of cooperation among schools. Other issues included a cultural issue. Students who preferred to start a career in the

public sector or to get a professional career rather than start their own business (Matlay et al., 2012).

The authors shed light on the importance of increasing entrepreneurship courses in engineering and science schools, which inspires startup business in high-tech sectors and enhance entrepreneurship attitudes and awareness among students (Matlay et al., 2012).

The study in (Milian & Gurrisi, 2017) provided basic insight at the online promotion of entrepreneurship education programs in Canada. The study showed how this education motivated students with collaborative learning experience and useful hands-on skills with a true entrepreneurial mindset. Also the basic strategies that has been used to do so. Moreover, a case study of (PSE) post-secondary education organizations and how they market themselves to students was presented, in addition to the tools that are used to do so, and to examine how entrepreneurship education is being marketed to students in the Canadian universities (Milian & Gurrisi, 2017).

The work by Küttim et al., aim to identify the entrepreneurship education resources (lectures, seminars, networking, coaching opportunities, and resources for entrepreneurs). In addition, the entrepreneurship education effects on students' entrepreneurial intentions in two European country groups (efficiency-driven and innovation-driven economics). The results show that there are more potential entrepreneurs in efficient-driven countries than in innovation-driven countries.

The Entrepreneurship education identified two groups of entrepreneurs: first is the entrepreneurial person who has intentions to be self-employed or interested to start his/her own business. The second group included those with the entrepreneurial behavior who are able to pursue entrepreneurship as employees and volunteer (Küttim et al., 2014).

Based on the reviewed literature, researchers either utilized a single existing course or a series of courses to introduce entrepreneurship principles. In other cases, new dedicated courses were introduced and added to the curriculum. However, in this work the authors considered the limitation of available credit hours to introduce new courses in entrepreneurship. Besides utilizing existing courses, the authors introduced a new training workshop leveraging the timeframe of an existing internship requirement.

## ENTREPRENEURSHIP TRAINING DESIGN

The School of Engineering at Princess Sumaya University for Technology (PSUT) added a compulsory Entrepreneurship training to build skills and attitudes required for engineering graduates. The initiative started for the first batch of students in summer 2016.

The offered training workshops included two delivery options/modes. The first delivery mode (Mode-1) was offered by Queen Rania Center for Entrepreneurship (QRCE) (Queen Rania Center for Entrepreneurship, 2020). QRCE is one of PSUT's centers that deliver Entrepreneurship services to the university and entire community nation-wide. The workshop was an on-campus face-to-face workshop. The second option that was available for students to take (Mode-2) was a self-paced online training course provided by PSUT Cisco Networking Academy (Academy/Princess Sumaya University for Technology).

The Mode-1 training by QRCE provides an overview of Entrepreneurship and Innovation, how to create business model innovation and business plan based on product demand and desirability, in addition to the design thinking process. While Mode-2 by Cisco Academy helps develop an entrepreneurial mindset, focusing on many skills such as business planning,

negotiation, financial literacy, and problem solving. The more detailed curriculum of the training delivered by the two modes is presented next.

### Mode-1 (QRCE) Curriculum

In this mode, students physically attend a 5-hours' workshop face-to-face training on-campus. Table 1, shows the course outlines and overview.

<b>Chapter</b>	<b>Overview</b>
<b>Business Model Innovation</b>	<ul style="list-style-type: none"> <li>• Innovation timeline</li> <li>• Types of innovation</li> <li>• Design thinking process</li> <li>• Personal criteria</li> <li>• Professional criteria</li> </ul>
<b>Business Plan vs. Feasibility Study</b>	<ul style="list-style-type: none"> <li>• Business plan components</li> <li>• Business concept components</li> <li>• Revenue streams</li> </ul>
<b>Ideation and Creativity</b>	<ul style="list-style-type: none"> <li>• Approached for innovative ideas</li> <li>• Product value</li> <li>• Design thinking model</li> <li>• Successful design thinking products</li> <li>• Design driven innovation</li> <li>• Banking innovation</li> <li>• The Double diamond for new product design</li> </ul>
<b>Innovation and Sustainability</b>	<ul style="list-style-type: none"> <li>• Types of innovation</li> <li>• Innovation and competitiveness</li> <li>• Sustainability and innovation</li> <li>• Sustainable innovation dimensions</li> <li>• Sustainable innovation stages</li> <li>• From product to service</li> <li>• Moving to CLOUD services</li> </ul>
<b>Product prototyping</b>	<ul style="list-style-type: none"> <li>• Types of prototyping</li> <li>• Reasons</li> <li>• Works like a prototype</li> <li>• Why it is important to choose material</li> <li>• Things to consider in mechanical design</li> </ul>

### Mode-2 (Cisco) Curriculum

The content in mode-2 is organized into seven modules that include practice activities and quizzes to assess understanding. Students can self-enroll in the course. The course is available in several languages such as English, Arabic, and Spanish. It needs 10-15 hours to complete. Table 2, overviews the modules covered by the course.

All students from all engineering majors at the school of engineering are mandated to take one of the previously described modes. Presenting the training completion certificate is a pre-requisite to pass the work placement course.

<b>Module/Case Study</b>	<b>Overview</b>	<b>Chapters</b>	<b>Skills</b>
<b>Changing for Expertise</b>	How to identify personal skills, define a product or service, and determine pricing. Additional topics include presentation skills and customer service, retention, and loyalty programs.	<ul style="list-style-type: none"> <li>• Recognizing expertise.</li> <li>• Generating income</li> <li>• Creating a presentation</li> <li>• Keeping records</li> <li>• Providing good customer service.</li> </ul>	<ul style="list-style-type: none"> <li>• Presenting</li> <li>• Selling</li> <li>• Identify legal structures</li> <li>• Understand ROI</li> <li>• Conflict resolution</li> </ul>
<b>Starting an Internet Cafe</b>	Introduces entrepreneurial thinking and explains how entrepreneurship differs from other employment opportunities. Business research tools are identified and a business plan is prepared.	<ul style="list-style-type: none"> <li>• Think like an entrepreneur</li> <li>• Plan like an entrepreneur</li> <li>• Decide like an entrepreneur</li> <li>• Writing the business plan</li> </ul>	<ul style="list-style-type: none"> <li>• Research</li> <li>• Develop a business plan</li> <li>• Entrepreneurial thinking</li> <li>• Understand business environments</li> </ul>
<b>Making a Business Successful</b>	Explores how to help a business remain profitable by defining a change process, reviewing advantages and disadvantages of product changes, preparing a change plan, and communicating changes to all stakeholders.	<ul style="list-style-type: none"> <li>• Review the business plan</li> <li>• Customer and market analysis</li> <li>• Implement, evaluate, and anticipate change</li> <li>• Revise the business plan</li> </ul>	<ul style="list-style-type: none"> <li>• Change process</li> <li>• Business assessment</li> <li>• Legal, social, and ethical responsibilities</li> <li>• Cost /benefit analysis</li> </ul>
<b>Taking the initiative</b>	How to transfer skills from one type of employment to another to succeed in the marketplace. Reviews the legal aspects of business ownership, and discusses how to prepare a funding proposal.	<ul style="list-style-type: none"> <li>• Using social networks as a business tool</li> <li>• Creating a consulting business</li> <li>• Funding a new business</li> <li>• Protecting the new business</li> </ul>	<ul style="list-style-type: none"> <li>• Social networking</li> <li>• Insuring a business</li> <li>• Identify funding sources</li> <li>• Prepare funding proposal</li> <li>• Assess personal skills</li> </ul>
<b>Enabling an E-Business</b>	Defines e-business and introduces ways e-business applications can be used to solve business problems. Project management is introduced and the tools used to measure the success of a business are reviewed.	<ul style="list-style-type: none"> <li>• What is broadband?</li> <li>• Prepared the business to use broadband</li> <li>• Assessing business performance.</li> </ul>	<ul style="list-style-type: none"> <li>• Decision making</li> <li>• Goal setting</li> <li>• E-business applications</li> <li>• E-business metrics</li> <li>• Internet marketing</li> </ul>
<b>Providing Outsource Services</b>	Explores the importance of formalizing business relationships through a contract, including the legal structure of a contract, a review of common business contract, and the request for proposal and resulting bid.	<ul style="list-style-type: none"> <li>• Employment opportunities in contracting</li> <li>• The role of contracts in business relationships.</li> <li>• The request for proposal</li> </ul>	<ul style="list-style-type: none"> <li>• Negotiation</li> <li>• Meeting protocols</li> <li>• Contract structure</li> <li>• Bid process</li> <li>• Pricing strategies</li> </ul>
<b>Building a Contracting Business</b>	Reviews several aspects of business ownership including resources, the decision making	<ul style="list-style-type: none"> <li>• Identifying the business structure</li> <li>• Creating a business</li> </ul>	<ul style="list-style-type: none"> <li>• Delegation</li> <li>• Business communications</li> </ul>

	process, contracts, and research. Also introduces normal business structures, departmental responsibilities, and establishing business credit.	structure <ul style="list-style-type: none"> <li>Expanding the business structure.</li> </ul>	<ul style="list-style-type: none"> <li>Resource acquisition</li> <li>Lending process</li> </ul>
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## RESULTS AND DISCUSSION

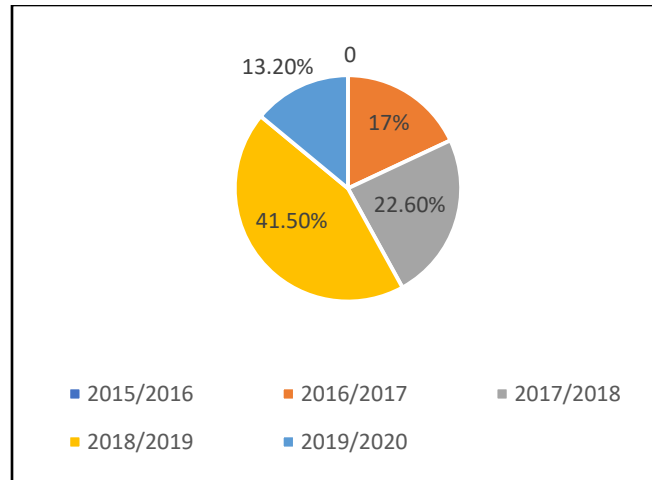
An online survey was used to capture and understand the impact of the compulsory Entrepreneurial training using the two modes on the students' mindset. It asked the engineering graduates to fulfill the Entrepreneurial training Scale Survey (Walter & Block, 2016; Souitaris et al., 2007).

The survey that included twelve questions addressed the following.

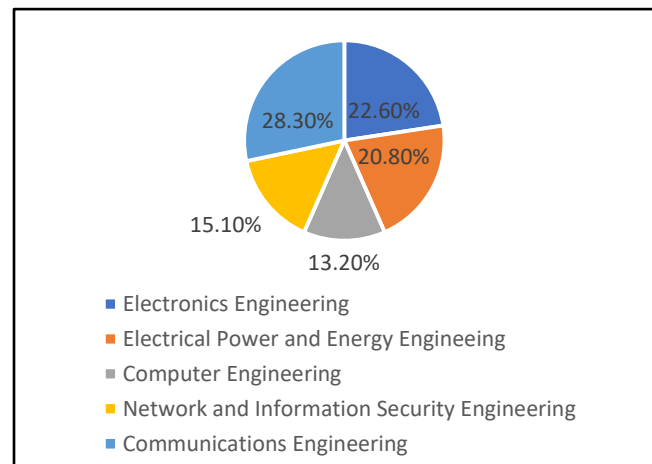
1. The Engineering Majors of the students.
2. The delivery mode that the student took.
3. The academic year when the student took the training.
4. Whether the training helped the student to develop their sense of initiative – a sort of entrepreneurial attitude.
5. Whether the training helped better understand the role of entrepreneurs in the society.
6. How the training made the student more interested to become an entrepreneur.
7. Whether the training helped provide the students with skills and know-how to enable them to run a business.
8. How the training helped create the understanding of attitudes, values and motivations of an entrepreneur (why entrepreneurs act).
9. How the training helped create the understanding of the actions needed to be taken to start a business.
10. How the training contributed to the understanding of the practical management abilities and skills needed to start a new business.
11. How the training contributed to the development of the abilities to create networks.
12. How the training contributed to the development of the ability to identify new opportunities (when to act).

Responses from 52 students were received. The responses by the students on the 12 questions are presented below in Figure 1 to Figure 12.

The 52 responses were from engineering students who graduated within four different academic years (2016-2020). Most of the responses were from those who graduated during the 2018/2019 academic year. This is about 41.5% of the total responses. The details are presented in Figure 1. It is believed that this is due to the fact that these were fresh graduates when the survey was conducted and still had stronger ties with the university communication channels that were used to communicate the survey to them.



**FIGURE 1**  
**THE ACADEMIC YEAR WHEN THE STUDENT TOKE THE TRAINING**

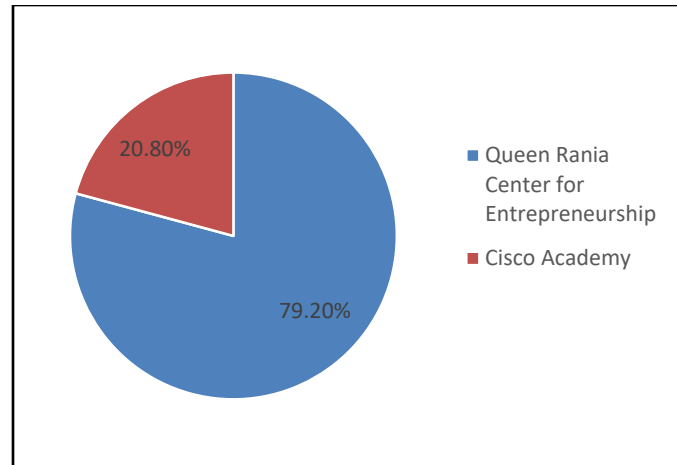


**FIGURE 2**  
**THE ENGINEERING MAJORS OF THE STUDENTS WHO RESPONDED TO THE SURVEY**

The highest rate of respondents was from the Communications Engineering and Electronics Engineering majors, with 28.3% and 22.6% of the total responses received respectively. Followed by Electrical power and Energy Engineering with 20.8%. Whereas, the lowest respondents’ rate was from the Network and Information Security Engineering and Computer Engineering majors with 15.1% and 13.2% correspondingly. The detailed breakdown of the responding students’ majors is illustrated in Figure 2.

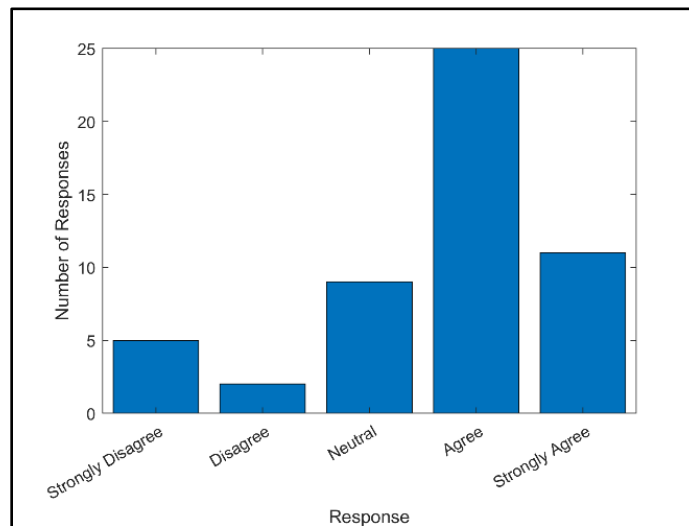
The results show that the majority of the respondents attended the Mode-1 workshop offered by QRCE physically on campus with percentage of 79.2% as shown in Figure 3. The other 20.8% attended Mode-2 of the training which was a self-paced online course by Cisco Academy.



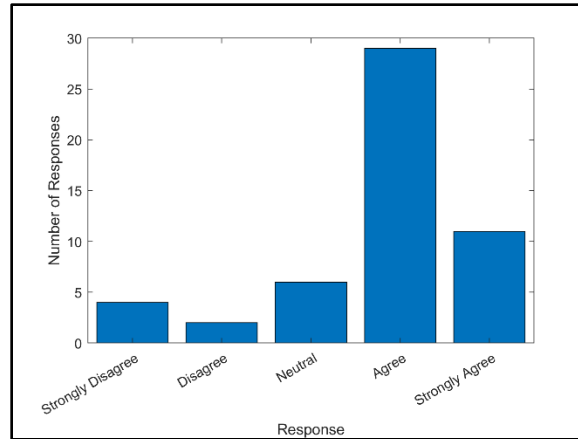


**FIGURE 3**  
**THE DELIVERY MODE THAT THE STUDENT TOKE**

The survey captured the degree of how the students think that the training helped them to develop their sense of initiative - a sort of entrepreneurial attitude. As shown in Figure 4, 69.9% of the responding students agreed that the training helped gain this entrepreneurial attitude. Additionally, from the students' perspective, the results showed that the Entrepreneurship course helped better understand the role of entrepreneurs in the society with 75.5% as illustrated in Figure 5. Moreover, as shown in Figure 6, 69.8% of the responding students agreed that the training created an interest in becoming an entrepreneur.



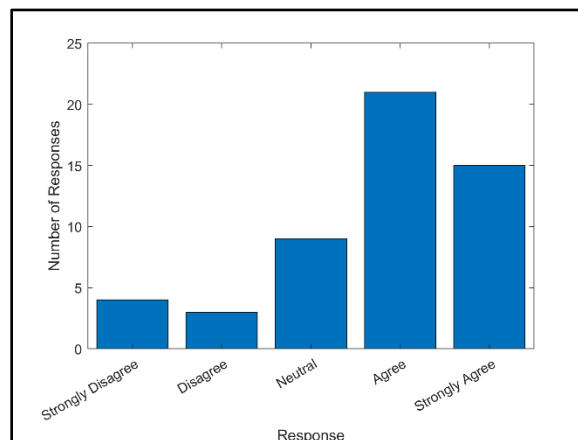
**FIGURE 4**  
**WHETHER THE TRAINING HELPED THE STUDENT TO DEVELOP THEIR SENSE OF INITIATIVE - A SORT OF ENTREPRENEURIAL ATTITUDE**



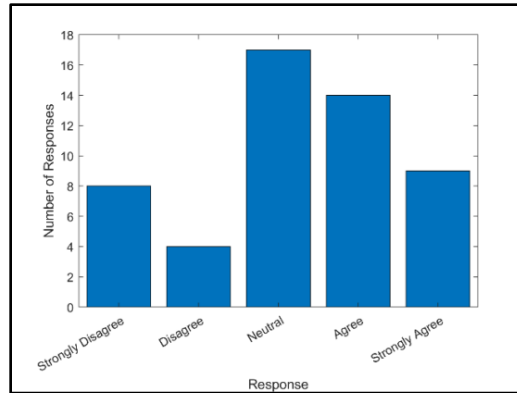
**FIGURE 5**  
**WHETHER THE TRAINING HELPED BETTER UNDERSTAND THE ROLE OF ENTREPRENEURS IN THE SOCIETY**

As illustrated in Figure 7, 43.4% of the graduates believe that the training helped provide them with the skills and know-how to enable them to run a business. Figure 8 presents the results of the graduate's responses to a question that asked them about how the training helped them create the understanding of attitudes, values and motivations of an entrepreneur and why entrepreneurs act. 77.4% of the responses agreed that the training helped in this aspect.

Also, 50.9% of the responses show that the training helped in attaining a very good understanding of the actions required to be taken in order to start a business as shown in Figure 9.

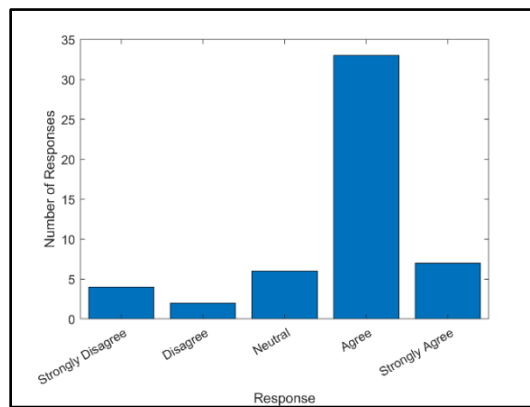


**FIGURE 6**  
**HOW THE TRAINING MADE THE STUDENT MORE INTERESTED TO BECOME AN ENTREPRENEUR**



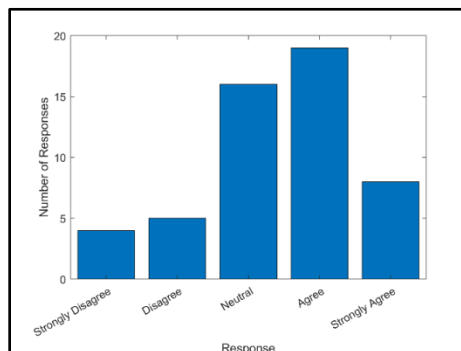
**FIGURE 7**

**WHETHER THE TRAINING HELPED PROVIDE THE STUDENTS WITH SKILLS AND KNOW-HOW TO ENABLE THEM TO RUN A BUSINESS**



**FIGURE 8**

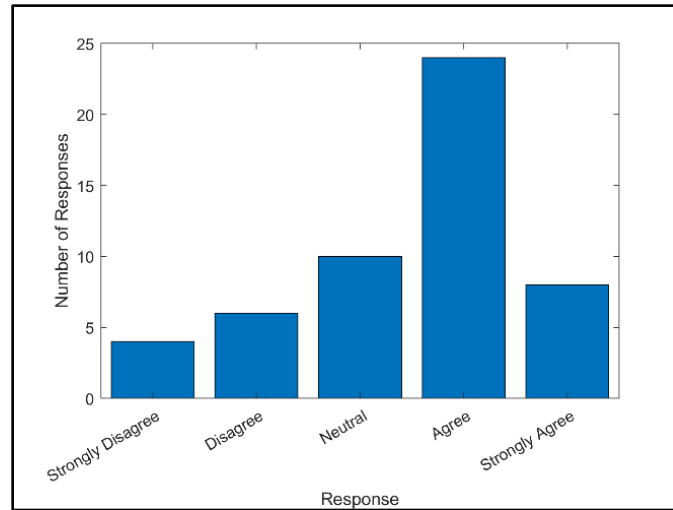
**HOW THE TRAINING HELPED CREATE THE UNDERSTANDING OF ATTITUDES, VALUES AND MOTIVATIONS OF AN ENTREPRENEUR (WHY ENTREPRENEURS ACT)**



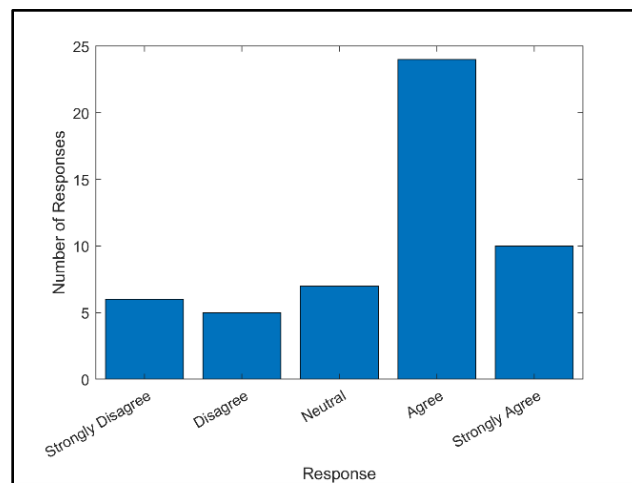
**FIGURE 9**

**HOW THE TRAINING HELPED CREATE THE UNDERSTANDING OF THE ACTIONS NEEDED TO BE TAKEN TO START A BUSINESS**

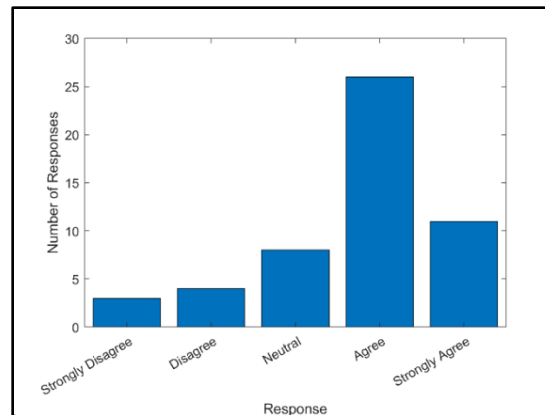
As shown in Figure 10, 62.3% of the students realized that the training contributed to their understanding of practical management abilities and skills needed for starting a new venture. The survey asked about how the training contributed to the development of the abilities to create networks. The results showed that 66.1% of the respondents agree that the training contributed to the development of this ability as shown in Figure 11.



**FIGURE 10**  
**HOW THE TRAINING CONTRIBUTED TO THE UNDERSTANDING OF THE PRACTICAL MANAGEMENT ABILITIES AND SKILLS NEEDED TO START A NEW BUSINESS**



**FIGURE 11**  
**HOW THE TRAINING CONTRIBUTED TO THE DEVELOPMENT OF THE ABILITIES TO CREATE NETWORKS**



**FIGURE 12**  
**HOW THE TRAINING CONTRIBUTED TO THE DEVELOPMENT OF THE ABILITY TO IDENTIFY NEW OPPORTUNITIES (WHEN TO ACT).**

Lastly, and as illustrated in Figure 12, 71.7% of the respondents agree that the training contributed to the development of their abilities in identifying new opportunities.

When analyzing the individual responses from all graduates who attended the two modes of training, i.e. the physical face-to-face training by QRCE (Mode-1) and the self-paced online course by Cisco Academy (Mode-2), no clear advantages of one type over another were found.

Finally, the findings show that the proposed workshops helped the student to develop their sense of initiative, better understand the role of entrepreneurs in the society, increased their interest to become entrepreneurs. Furthermore, the training helped develop skills, abilities, know-how and actions needed to enable them to run a business. All of this in addition of creating attitudes, values and motivations contributed to the development of the students' entrepreneurial mindset.

## CONCLUSION

The lack of entrepreneurship subject area to cover the required knowledge in engineering curriculum triggered the authors to propose a workshop integrated with the work placement graduation requirement to address entrepreneurship. The workshop was introduced into two modes. In the first mode, the workshop was offered by QRCE physically on campus. The other mode was a self-paced online course by Cisco Academy. The students in the last four years who went through this training were surveyed and asked about how the workshop helped in different aspects of bringing awareness and understanding of entrepreneurship mindset, attitudes, understanding, know-how, skills and abilities. The results show that the training workshop in its two offering modes was very successful and achieved its purpose the attitudes and mindset.

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