Changing Minds, Transforming Learning Environments: A Collaborative Approach to Innovation and Entrepreneurship

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Introduction

The national government of the United Arab Emirates has set transitioning to a knowledge-based economy, including the promotion of innovation and entrepreneurship, as a key pillar of its Vision 2021 National Agenda [1]. With this initiative, the country seeks to develop its human capital with particular emphasis on establishing "a competitive economy driven by knowledgeable and innovative Emiratis." The country aims to harness the full potential of its national human capital by encouraging entrepreneurship and innovation. It seeks to develop "dynamic entrepreneurs" who can "bring innovative products to the marketplace," thereby transforming its economy "into a model where growth is driven by knowledge and innovation." The country has identified instilling an entrepreneurial culture into schools and universities as one important means for fostering leadership, creativity, responsibility and ambition in the new generation – a means for cultivating "a healthy risk-taking culture where hard work, boldness and innovation are rightfully rewarded" [1].

As part of its 2015 Year of Innovation, the UAE Ministry of Education entered into a collaboration with Stanford University to develop an innovation and entrepreneurship course to be taken by all university students in the country, a course based on the decades of practice and experience teaching these skills at Stanford University. The overall aim of the course is to support the UAE's national strategy on innovation and accelerate its innovation talent development by equipping the next generation of Emiratis with an innovative and entrepreneurial mindset and its related core skills. In this paper we document the implementation of this unique course at one particular engineering university in the UAE and explore the impacts it is having on both students and instructors by listening to their voices and observing their actions.

Background

Entrepreneurship education (EE) in higher education has seen tremendous growth over the past decade in many countries around the world [2]. Initially EE was taught mainly in business schools; more recently it has been offered as an elective course across many other disciplines, including engineering. A main impetus for an emphasis on EE in higher education is that it can be a significant contributor to economic development and job growth of a country [3]. In addition to the potential direct benefits on the economy of a nation in general, research has also shown that EE can contribute to greater student engagement and motivation during their education – motivation which has been seen to transfer to their future workplace as well [4].

Innovation is a related concept that is also often addressed as part of entrepreneurship education. Indeed, for a country to create jobs and prepare workers to adapt to rapidly changing technologies, it is essential to prepare its human capital and provide innovation opportunities. With reference to engineering education, it has been found that science and engineering students who are involved in entrepreneurial activities during their studies end up creating more high

quality startup companies, companies that contribute to overall job growth [5]. The question remains, though, whether, and if so, how, we can promote an innovative and entrepreneurial mindset through undergraduate learning experiences.

The Theory of Planned Behavior (TPB) serves as a starting point for answering this question. TPB suggests that becoming an entrepreneur is a planned behavior, and entrepreneurial intentions often precede entrepreneurial behavior. Maresch et al [6] have documented that EE can contribute significantly to the development of entrepreneurial intentions in students. EE helps to nurture an entrepreneurial mindset among students, a fact that has been documented for engineering students [7]. Kriewall and Mekemson [7] expand on this change in mindset by illustrating the dimensions of an entrepreneurial engineer through their KEEN pyramid (see **Figure 1**). The pyramid indicates four core attributes of an entrepreneurial engineer: technical fundamentals, customer awareness, business acumen and societal values, covering a number of the ABET a-k criteria. These attributes play out across three sectors – engineers, intrapreneurs, and entrepreneurs. Engineers and Entrepreneurs are well known. Intrapreneurs are those engineers who stay within a company, not starting their own businesses, yet taking direct responsibility for turning an in-house idea into an efficient new process or a profitable new product, service or business for the company. Perhaps most importantly EE helps engineering students to acquire more than just technical knowledge, it inculcates an innovative and entrepreneurial mindset, a mindset which may lead to them becoming either an intrapreneur or an entrepreneur.
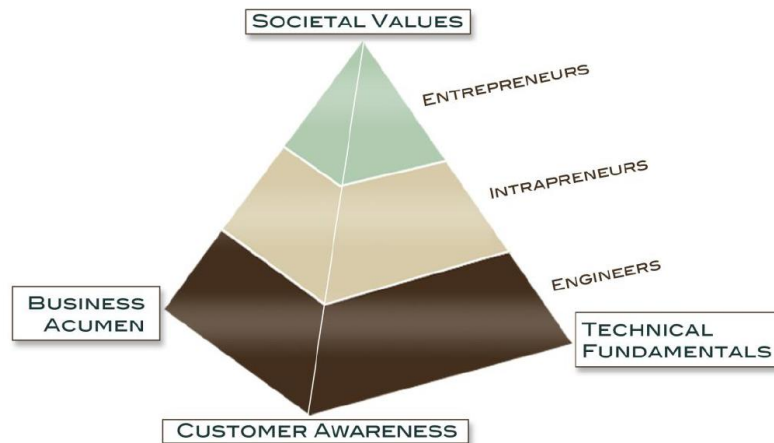

Figure 1. KEEN Pyramid [7]

An added benefit of EE is that as students develop innovation and entrepreneurial skills, competencies and mindsets, they also enhance a number of non-cognitive aspects of competence such as perseverance, self-efficacy, life-long learning skills, and social skills. These competencies align with those promoted by the Organization for Economic Co-operation and Development (OECD) [8] as necessary for participation in a knowledge-based society. These competencies are a) using tools (language, symbols, texts, knowledge, information and technology) interactively, b) being able to interact well in heterogeneous groups and work in teams, including managing and resolving conflict, and c) acting autonomously, which relates to

being able to act within the big picture, form and conduct life plans and personal projects, and defend and assert rights, interests, limits and needs.

Ongoing efforts to improve engineering education have frequently called for pedagogies that promote active engagement of students. Such approaches place an emphasis on *educating* engineering students versus simply *training* them. EE provides an ideal means of achieving this through the ways in which it can transform the learning environment. EE, by its very nature, requires learning environments that allow students to use their creativity and to apply their knowledge to find new solutions to problems connected to the environment outside the university. In so doing, EE provides opportunities for students to learn from their society's cultures, market and economy [9]. When compared to other active, student-centered approaches such as problem-based learning, project-based learning, and service learning, EE potentially covers a much wider range of the areas often sought as part of today's pedagogies [10]. **Table 1** lists these desired areas in the left column and indicates the coverage of the different active, student-centered approaches.

Table 1. Comparison of Pedagogical Approaches [10].

Major focus on	Entrepreneurial Education	Problem-based Learning	Project-based Learning	Service Learning
Problems	X	X	X	X
Opportunities	X			
Authenticity	X	X	X	X
Artifact creation	X		X	
Iterative experimentation	X			
Real world interactions	X			X
Value creation to stakeholders	X			X
Team-work	X	X	X	X
Work across extended periods	X		X	X
Newness/innovativeness	X			
Risk of failure	X			

As evidenced in **Table 1**, in addition to changing mindsets and developing core skills, EE also can serve as a means of transforming the learning experience for both student and instructors. To determine the degree to which this is happening, we listened to the voices of students and faculty who have recently experienced the introduction of EE into their curriculum.

Local Context

Of the approximately 121,000 students who were enrolled in 71 licensed universities, colleges, and higher education institutes in 2014 in the United Arab Emirates, sixty percent were UAE nationals, with the remaining forty percent made up mainly of children of expatriates who have grown up in the country. The majority of university students major in Business, Engineering and Information Technology. According to a survey by the outsourcing company TASC, eight out of ten Emirati graduates prefer to work for the government sector rather than the private, as it is

believed to offer better salaries and benefits. Another survey, this one with a sample population of 1080 students conducted by the Ministry of Education in 2015, revealed that while thirty-eight per cent of the students expressed an interest in becoming entrepreneurs, most lacked the preparedness to do so [11]. These findings helped to serve as further impetus for the development of a course to be offered to all university students in the UAE, independent of the discipline they are studying.

The innovation and entrepreneurship course collaboratively developed is a Stanford - informed approach to learning innovation and entrepreneurship that, in theory, can be applied to any high-growth enterprise or other organization in the UAE. The initiative includes a self-paced, online resource designed to provide UAE faculty with content, pedagogies, and teaching tools to teach the course effectively in the UAE. The course was introduced as an elective in select universities in 2015; it became mandatory in all higher education institutions, public and private, in fall 2016. The course is designed to provide students with learning experiences that instill a mindset of innovation and entrepreneurship in the next generation of Emiratis along with the related skills. The course was also intentionally designed in such a way as to promote student-centered, active learning environments in higher education settings.

The implementation of the innovation and entrepreneurship course discussed in this paper took place at a university that offers degrees in engineering and the sciences to approximately 1500 undergraduate and nearly 400 graduate students. As an English medium university in an Arab speaking country, nearly 100% of students have English as an additional language. Just over half of the matriculated undergraduate students are female. Most of the undergraduate students are coming from local government high schools that have traditionally promoted a concept of learning through memorization and repetition of problem solving algorithms, with little application of knowledge or opportunities for innovation and creativity.

Faculty selected to teach the course attend several training seminars and workshops, including webinars. Stanford University also provides extended training for selected faculty members through a series of activities and experiences that help to develop and enhance their own entrepreneurial and innovative design capabilities. In essence, the faculty are provided with an experience similar to that which they will provide for their students. As one of the faculty trainers pointed out, a key to teaching the course well is to have "a willingness to go through the same process that the students will go through." To date, two cohorts have completed this intensive training, with a third scheduled to attend the week-long training in summer 2018.

The Fundamentals of Innovation and Entrepreneurship course for students, which is taught in the junior year at our university, is composed of three modules: Design Thinking, Entrepreneurship, and Growth and Leadership. Most sessions include a variety of activities: mini-lecture, discussion, interactive activities in class, and open Q&A. The course materials for each session consist of specified learning outcomes, concepts, layouts, PowerPoint presentations and resources that include readings, relevant videos, exercises, assignments, and study questions pertinent to the session. Each of the three modules is described below.

Module I: Design Thinking In this module, students are introduced to the creative mindset and practices that enable innovation and entrepreneurship. After establishing the mindset, students explore creativity and the sources of innovative and entrepreneurial ideas. Students are then introduced to the design thinking process through need finding, empathy, idea generation, prototyping, and experimenting.

Module II: Entrepreneurship In this module, students learn how to develop vision and mission statements for an organization and create specific goals for a new enterprise. They learn how to differentiate between an idea and an opportunity to start and grow a high-impact enterprise. The Lean Startup concept, which involves customer development, agile programming, and use of the business model canvas, is introduced. Essentials of venture financing, team and organizational development, and legal issues are also discussed and applied in the module.

Module III: Growth and Leadership The third module focuses on the challenges of leading and innovating in organizations during periods of rapid change. It also includes sessions on how to leverage cross-organizational opportunities and build a collaborative culture to enable innovation.

The course grade is based on class participation, two team-based projects, and a personal business plan. The course learning outcomes are as follows:

- Students can describe the difference between innovation and entrepreneurship.
- Students can explain the processes of innovation and entrepreneurship.
- Students can distinguish between ideas and viable opportunities.
- Students can demonstrate skills, or improvement on skills, that are needed to form effective (diverse) teams.
- Students can explain the value of innovation and entrepreneurship for their society and economy.
- Students can articulate the value of innovation and entrepreneurship for their own careers.

In the following section we discuss the impacts of the early implementation of this unique course on both the students and faculty in the engineering programs at our university, as expressed by the participants themselves.

Impacts of Innovation and Entrepreneurship Course

At this early stage in the implementation of the course at our university, we sought to follow the ideas taught in the course by listening to the voices of the end users – the students and faculty. A mixed methods approach was used to explore the impacts of the implementation of the required Fundamentals of Innovation and Entrepreneurship course in the curricula of engineering programs at our university on our female students (male and female students are taught separately). A combination of student focus groups, faculty focus groups and classroom ethnography provide insights into the transformative nature of the content and pedagogical approaches of the course, both in what and how students learn and on how faculty teach. Focus group discussions were guided by a semi-structured protocol developed to promote conversation

around key issues. The discussions were recorded and later analyzed to identify emergent themes. Classroom ethnography served to triangulate the data gathered through the focus groups. All names used in the following text are pseudonyms to provide anonymity and protect confidentiality.

One of the most exciting aspects to arise out of the focus group discussions was the level of enthusiasm and interest expressed by both students and faculty. For most students this class is viewed as a very much appreciated break in the routine of their engineering coursework. When asked what stood out about the course, students frequently reference its uniqueness within the engineering curriculum. For Fatima, the course "… is very different. It's new material. We never took anything related to business before." For Midoor, "This course is totally different. If you have three courses that are the same and then one that is different it's better, it brings out creativity." Faculty also point to the newness of the material for the students as a reason for why it is so engaging. This level of engagement was confirmed by classroom ethnography, with no students observed checking their phones or surfing the internet during class activities. Several instructors also noted how students often remain beyond the end of class to continue working on their projects. The enjoyment expressed by students is not a matter of the course being seen as "easy." Rather, as Noura B, explained, "We like this course. It is not the same like our major courses. We put a lot of energy into it." Students refer to it as a course that requires deep thinking about many things they had not previously encountered. This has a lot to do with the structure of the course and the animated discussions that take place in small groups and teams. For Fatima, one of the best parts of the course is "The teamwork, and … (3 second pause) … when different minds come together." For faculty, the discussions and listening to the ideas of students are also mentioned as one of the most enjoyable parts of the course.

For faculty, teaching the course also brings excitement and joy into their teaching. They all express a great appreciation for having had an opportunity to teach the course. For many, some of the information in the course was also new to them, and this provided faculty an opportunity not only to teach, but also to learn. In this way, they truly are facilitators rather than the "sage on the stage." As one of the Stanford University trainers stated, "In this course you are the tour guide. If you help students walk through the experience, then you have done your job." The course discussions and student ideas range so broadly that no one instructor could or should be expected to know everything. In these situations, the faculty instead model how to learn, how to find the needed resources and expertise, enabling students to further develop life-long learning skills. Some, but not all, instructors have been entrepreneurs themselves. However, that is not a requirement to successfully teach the course. "To be successful teaching this course you have to be excited about it. You really have to have a passion. It is not something that you just go and present things to the students."

Faculty and students both commented on how the course brings what is happening in the world into the classroom, while also getting students out into the community to talk with people. Perhaps the clearest indication of how well the course is received is the overwhelmingly positive responses given when students are asked if they would recommend it to others, with Noura's

response typical, "I would highly recommend it. It is the best from all of the engineering courses we have taken."

Changing Mindsets While the course is enjoyed by both instructors and students, it is doing much more than providing entertainment; it is also clearly meeting its goal of changing mindsets. According to one student, Khulood, after taking the course "We don't think about the future in the same way." Taking this course leads students to look at the world differently. For Mariam, "It [the course] helps us. I learned a lot for my life. I look at things differently. It gets us to focus on our surroundings." Selma shared how prior to the course she would approach things in one fixed manner. After her experiences in the course, particularly the empathy sessions of Module I, she noted that she had "learned that we should look at things from the other side. So when we approach people, it's different." In addition to being open to different ideas and more actively listening to others, the students also shared how viewing the world differently has already affected them personally. Muna began by noting how the course activities and interacting with people outside of the university "makes me more confident." Shaima added to this, stating "Now we see, and we're like, we need to do something about that." Many students shared how the course has changed the way they think about how to use what they are learning in their engineering studies. In the words of Mouza, "Now we observe, before when we took math, calculus, and physics, we only thought about the problems that we needed to solve. When we took this course, I feel like I am now more open to the environment around me. I feel like all this should be fixed, that, like, this would be a great idea to apply. I started to have more ideas."

This concept of starting to have more ideas is one of the main goals for introducing entrepreneurship education into the curriculum – to create a generation of young people who see the world as a place of opportunity, a chance to innovate and contribute. That this is happening was expressed by several students through statements such as, "Now when we see a problem or something, we look for solutions and think of a plan." For Mouza and others like her, it changed their perception of who they are and can be: "I never thought that I could actually think in a business-like manner. I was shocked, to be honest." Faculty indicated that they do notice a change in mindset of students over the semester; however, they are less convinced that the students really believe that they can do it, that they can be an entrepreneur. The voices of the students indicate otherwise.

Intrapreneurs and Entrepreneurs From the course, students gain a solid understanding of startups and businesses, an understanding that they did not previously have. They learn specific skills, how to use a business canvas, and how to do cost projections. In learning these things, Samah felt that "The class has changed how we think about stuff. Even if you don't want to start up a business, like, you can look at other businesses and understand them." The exploration of entrepreneurship in the course plants seeds that are likely to grow. It helps to bring about changes in mindset that may lead these engineering students to use their engineering discipline knowledge to start a business, helping to meet the goals of their country. For others, they may never go on to start a business. However, they will take their design thinking and entrepreneurship mindset into the company or government sector where they are employed. There, they will apply this mindset to improving processes and perhaps generating innovative

ideas – in other words, they will become intrapreneurs. Either way, entrepreneur or intrapreneur, the country will benefit. As Selma expressed, "We used to think that engineering is something else, and, like business and entrepreneurship is something else. But when we took this course we saw that that they are actually related. And you can be both, an entrepreneur and an engineer." For Mira, "It's not only the engineering aspects. I can open my own shop for something with engineering, I can link my careers." When asked if they think they could start a business, the students respond with a resounding "Yes!" When asked if they had felt that way before the course, they answer just as clearly "No, never. Never ever." Without a doubt the students are reacting to the course the way that the Ministry and the course developers had hoped. In the words of Mouza, "I think I can start with a good idea…that's all you need."

Transforming the learning environment What makes this course so successful? The answer is a combination of things. First the climate in the country is opening up to new opportunities, and young Emiratis are being encouraged to actively participate. They are able to connect ideas being learned in the course with the stories they regularly hear in the daily news. The UAE is fast becoming a thriving place for startup companies as the number of co-working spaces, incubators, accelerators, training programs, events, and networking opportunities available to entrepreneurs increases rapidly. In 2015, the UAE attracted 41% of the venture capital in the Middle East and North Africa (MENA) region and over $280 million were invested in tech-startup companies [12]. Already, there are four startups in the UAE worth more than $1 billion each. Secondly, the course is specifically designed to engage students in active learning activities that stimulate their interest and motivate their learning. The students who participated in the focus groups predominately described their high school math and science classes as ones in which the teacher introduced the topic, worked some example problems on the board and then had the students work similar problems in class. They described university mathematics and science classes as very similar in approach, with the main difference being that the teachers do more talking in their university classes and expect the students to do the individual work independently outside of class.

Not only the content and activities, but also the physical space can make a difference. One instructor had the opportunity to teach the same group of students in two different settings, one a traditional classroom with rows of desks and a whiteboard at the front, and the second a classroom specifically designed to support student centered active learning (see **Figure 2** for a photo of the second classroom space). The structure of these ALPs (active learning programs) classrooms creates a different feel, almost as though the students are not sitting in school. Another instructor stated that teaching in such a physical environment "is crucial." The students agree, commenting on how much better the ALPs classroom structure is for discussions, teamwork, research and presentations.

Figure 2. Active Learning Programs (ALPs) classroom where the Fundamentals of Innovation and Entrepreneurship at our university is taught. The physical structure supports student-student interaction. The technology provides ease of access to materials and multiple display screens.

For all of the students, the Fundamentals of Innovation and Entrepreneurship course is clearly "Very different, in a good way…we always look forward to the class." It is a class that presents "new material, new and interesting things." The class involves engaging discussions, which both students and instructors identify as key to the learning that takes place. Faculty and students both make efforts to incorporate local materials beyond the standard resources provided by Stanford University. Classroom discussions often lead to the incorporation of examples of local entrepreneurs. Students do have suggestions for improving the class, including inviting more guest speakers into the classroom who could talk about their experiences, successes, and failures as entrepreneurs. They also recommend more activities that involve moving around in class and suggest making trips to startup companies to get a feel for what innovation and entrepreneurship look like in practice. Several, being engineering students, express a desire that the building of a prototype for their proposed product be part of the course. The faculty focus group participants concur with this idea and even began to discuss ways to connect the course with senior design projects to link more closely with engineering design and capstone activities, highlighting the need for students to be able to take their ideas further, to be able to experience the truly iterative nature of innovation and design.

Next Steps

As the global economy continues to witness significant economic changes, engineering universities in the UAE and throughout the world will have a vital role to play in developing an innovation and entrepreneurial mindset, unlocking the potential of students. In this paper we have described the approach being taken within the UAE, with a particular focus on the impacts a nationally required innovation and entrepreneurship course is having on students and faculty at one technological university. The findings of this initial study have led faculty to propose adapting the course in two ways. First, the content can continue to be modified to make it more relevant and culturally appropriate to the lived experiences of the UAE students. Second, the desire of our engineering students to include the building of a prototype as part of the course is leading us to consider expanding the course to also encompass aspects of a more traditional cornerstone engineering design. Future discussions will focuses on the development of a vertical sequencing of learning outcomes and performance indicators. By establishing a scope and sequence of outcomes across a vertical spine of design and entrepreneurship courses we hope to lay the groundwork for promoting transfer of knowledge and skills both to subsequent courses

and to future endeavors, whether as an intrapreneur within a company, or as an entrepreneur contributing to the national economy.

Over the long term, the broader impacts of this initiative will be explored through a series of national key performance indicators such as the Global Innovation Index and the Global Entrepreneurship and Development Index (GEDI). The first measures the performance of innovation in a country, while the latter is an indicator that looks at entrepreneurial attitudes, entrepreneurial activity, and entrepreneurship aspiration [1]. It is these measures that will provide a broader indication of the degree to which this national initiative is impacting the country. That it is likely to do so is clear from listening to the voices of those participating in the early implementation of the course - things are definitely heading in the right direction.

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