

# Maker Education as an Early Intervention to Catalyze the Development of Pre-entrepreneurs in Underserved Communities

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## ABSTRACT

Entrepreneurs create jobs, generate wealth and solve problems in communities. Developing entrepreneurship may be the fastest way to transform a community with limited resources. What if more entrepreneurs can be catalyzed and nurtured in communities from ordinary people to realize their potential? What if we can lower the average age of a successful startup founder by 10 years, from the 45 years that it is now? [1] What is the impact of maker education workshops on the human capital assets of its participants? These questions are the focus of an on-going experimental maker education program currently implemented in Kedah, Malaysia at 10 high schools in underserved communities. More than 120 high school students applied to partake in maker education workshops starting May 2019 until November 2019. Next steps of the research project include continued implementation of maker workshops and surveys, and initial analysis of data.

## INTRODUCTION

The objective of increasing the number of entrepreneurs within economies is underpinned by the motivation of governments and development institutions to attain more inclusive growth. While the International Monetary Fund (IMF) projects an upward trend for GDP growth, there are serious concerns about a historic growth in inequality globally. [2] Entrepreneurship is seen as a key contributor to bridging this gap given its impact on job generation and diversifying access to income opportunities for the labor force. [3]

Entrepreneurship Education and Training (EET) is the most prominent development approach that enhances the human capital of its participants for innovative and productive activities. The approach assumes that individuals with more human capital are better poised to take advantage of new or emerging economic activities. [4] EET, however, typically focuses on very specific audiences: nascent entrepreneurs or active entrepreneurs. Such a focus limits its intended impact because EETs do not engage the larger group with unrealized potential, who could be nurtured to build skillset and mindset to be prepared to take on entrepreneurship journey; a phase we call “Pre-entrepreneurship”.

This paper focuses on the impact of maker education workshops as an early intervention for a broader and larger audience who can become “pre-entrepreneurs.” The research studies the impact of maker education workshops on

## RELEVANT LITERATURE

### *A. EETs ARE CONCEPTUALLY TOO FAR TO GRASP AND UNDERSTAND FOR PRE- ENTREPRENEURS*

A meta-analytic review done by Martin, McNally, and Kay (2013) [5] compares the outcome effects of Academic (education) Programs to those of Training, and also finds that EET studies often entail academic interventions (25 out of 42 articles studied by Martin et al) on the undergraduate and postgraduate level. These studies often examine the differences in knowledge, skills, and attitudes between individuals that chose to take entrepreneurial degrees and courses, over those that did not. In effect, likely nascent entrepreneurs are compared to non-entrepreneurs (or latent entrepreneurs) in the control group. For Trainings, which are relatively, short interventions focusing on core entrepreneurship knowledge and skills, the audiences typically tend to be either nascent entrepreneurs or already-entrepreneurs. Often, entrepreneurial training studies primarily observe the impact on micro-entrepreneurs, small business owners, or start-ups.

With the objective of engaging nascent entrepreneurs and active entrepreneurs in mind, the following observations are relevant: (1) EET content mainly focuses on business concepts such as human resource management, marketing strategies, and operations; and (2) EET delivery is focused on pedagogical methodologies appropriate for nascent entrepreneurs or already-entrepreneurs that include education programs through: (2.1) bachelor’s and master’s concentrations on entrepreneurship and (2.2) complementary educational programs in management and/or entrepreneurship (e.g. internships) or education trainings through: (2.2.1) competitions and hackathons and (2.2.2) intensive short-courses among others. To fully understand the impact of an EET intervention, person, context, and pedagogical indicators relevant to the context of the objects of study is necessary. [6]

Educational psychology theory first proposed by Thorndike and Woodworth (1901) states that the transfer of learning is significantly influenced by the perceived relevance of content taught. In that respect, conducting an EET training for nascent entrepreneurs and active entrepreneurs makes sense as an appropriate learning approach since it is contextually “near” to the target audience. [7] This is consistent in current EET literature as most interventions engage individuals who are already taking preparatory steps towards entrepreneurship, or at the very least, develop entrepreneurial qualities and characteristics. However, that also implies that implementing EE to a broader and younger audience (that may not be immediately interested in self-employment) may be less

effective, since the content material can be considered too “far” or farther (irrelevant, less relevant) from the many different participants’ contexts.

Given this, there is an opportunity to contribute to the body of literature that builds on the “true latent entrepreneurs”, following Gohmann’s (2012) definition that describes individuals who prefer to be self-employed but are not currently self-employed or actively working towards that status. [8] The study aims to characterize an emerging concept: “Pre-entrepreneurship” referring to individuals who wish to become entrepreneurs, possess key entrepreneurial knowledge, skills, and attitudes, but have yet to venture into actual entrepreneurial activities.

This investigation focuses on individuals transitioning into latent entrepreneurship and understanding how a broader audience can be reached to consider self-employment as a legitimate career choice. While research on EET mainly assesses the effectiveness of training among groups immediately interested in entrepreneurship, or business, this study views maker education as an alternate and contextually nearer intervention to traditional EET that engages a broader audience who are not yet interested in an entrepreneurial career.

### *B. MAKER EDUCATION: AN ALTERNATIVE APPROACH TO DEVELOP HUMAN CAPITAL RELEVANT TO PRE-ENTREPRENEURSHIP*

The Maker Movement “consists of people utilizing technology to collaborate in creating tangible, material artifacts.” [9] This community practice of collaborating creates tangible, material artifacts, as “made with skill” referring to the original Latin meaning of the word. There are three key dimensions that the Maker Movement provides access to: (1) Technology, referring to hardware tools (e.g. 3D printers) that allow fabrication, production, and manufacturing; (2) Community, referring to maker, hackers, and tinkerers who collaborate and share technologies and designs with each other; and (3) Space, referring to a physical set-up where the Maker Movement community can collaborate together - these are sometimes called makerspaces and fabrication (fab) labs. [10] Maker Movements rapidly accelerate the act of “making” artifacts through collaboration, rapid prototyping, and learning by doing. [11] The act of making is defined as:

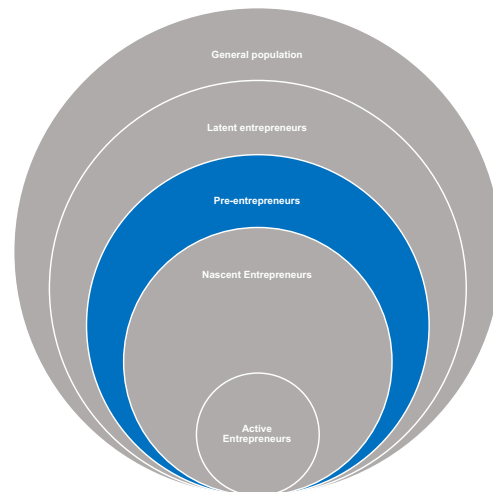
“Constructing activities and related ways to fabricate real and/or digital things using technological resources, including fabrication, physical computing, and programming. Making focuses on the process that occurs in an environment that is not always merely learning oriented, but promotes design thinking, computational concepts, collaborative work, and innovation, among other things.” [12]

The three dimensions serve as the foundations of the Maker Movement and allow for increased access to the process of making. Theorists describe the Maker Movement as a democratization of access to information on using tools for making [13] and entrepreneurship itself. [14] As makers create new products that are useful to their immediate environments, the shift from simply making, referred to as hobby-

ists, to individuals that develop entrepreneurial intent, referred to as lifestyle entrepreneurs, is natural. [15]

Although there is sparse literature on the connection between making and entrepreneurship, the process of making itself is a conceptually nearer pedagogical approach to entrepreneurship for individuals with no specific interest for entrepreneurship to transition towards pre-entrepreneurship, compared to EETs. The study aims to contribute to the stream of research that examines the impact of Maker Movements, specifically maker education, on the development of entrepreneurs by encouraging individuals with no specific desire for self-employment nurtured with the right human capital, developing into pre-entrepreneurs.

A literature review reveals that the body knowledge on entrepreneurship and EETs mainly focus on nascent and active entrepreneurs. Exceptions to this include research from Athayde (2009) and Gohmann (2012) on latent entrepreneurship. There is a critical step in between latent and nascent entrepreneurship that will be valuable for institutions interested in developing more entrepreneurs: pre-entrepreneurs. This study defines pre-entrepreneurs as individuals who have built self-efficacy related to entrepreneurial skills and wish to build on these skills towards more enterprising activities.



*Figure 1. Situating Pre-entrepreneurs*

### **RESEARCH GOAL**

The study examines an alternative route to developing entrepreneurs that brings individuals who participate in intensive short-course training programs, specifically maker education workshops, contextually closer to the discipline of entrepreneurship. Specifically, the study investigates the impact of maker education workshops on human capital assets, specifically individual’s entrepreneurial attitudes, innovation skills, social engagement, and academic performance. This research asks the question: what is the impact of maker education workshops on the human capital assets of its participants?

### **EXPERIMENTAL DESIGN AND PROCEDURE**

#### *A. WORKSHOP INTERVENTIONS*

Three workshop interventions will be implemented as part of

this experiment from May 2019 until November 2019. These include:

- 1) **Intervention 1: Introduction to Maker Education Program (I1):** The introductory workshop was held in mid-May of 2019. This workshop introduces the maker education curriculum to 2 teachers and 6 students from 10 local schools. In addition, schools receive maker labs in a box allowing for follow up workshops that can support up to 50 students for 6 months. In addition, schools are tasked to assign lab technicians who will be supported by mentors from the organizers. These three components support catalyzing the maker movements by providing access to maker tools, building a community of makers, and ensuring a physical space for continued maker activities. Ownership of equipment, materials, and supplies will be transferred to schools.
- 2) **Intervention 2: Strengthening Innovation Ecosystems in High Schools (I2):** 5 schools will be randomly selected to receive supplementary training on how to strengthen innovation ecosystems in their contexts. This allows researchers to study the “ripple effect” to demonstrate control over the treatment effect.
- 3) **Intervention 3: Maker Workshop Competition (I3):** Maker workshops culminate through a state-wide competition that will bring all 10 high schools and their students to participate in a spirited competition that celebrates each institution’s commitment to creativity and innovation.

#### B. ZERO2MAKER DESIGN CHALLENGES (ZDC)

In between interventions, participating high schools will continue to implement the program with their students. Design challenges will be released every month for schools to accomplish. Participation in these monthly challenges will be part of the basis for selecting winners during I3. Students receive mentoring online and in person for 3 to 4 months while they build maker skills and attract other students to the movement. A final challenge will be released in November – where all 10 schools will come together for I3.

### METHODOLOGICAL APPROACH

#### A. PARTICIPANTS

More than 120 students from ten high schools applied to take part in the maker education workshops. Final participants were selected through a lottery method – 60 high school students were randomly chosen (treatment group) while the rest were promised slots during next year’s maker education workshops (control group). All students are required to accomplish staggered surveys to measure changes in entrepreneurial attitudes, academic performance, innovation skills, and social engagement. The survey instrument also captures demographic information to increase granularity of future data analysis.

#### B. MEASURES

- 1) **Entrepreneurial attitudes (EA):** This is measured using Athayde’s (2009) [16] instrument and is an appropriate scale since the original study is intended for latent entrepreneurs. This is an 18-item tool that measures leader-

ship, creativity, achievement, and personal control – all of which are relevant to maker education workshops conducted. In addition, a 2-item scale measuring entrepreneurial identity adapted from Hagger and Chatzisarantis (2006) [17] is used and complemented by self-develop items that capture career preference and their certainty in pursuing these options. These measures are critical components that build the theory of pre-entrepreneurship.

- 2) **Innovation skills (IS):** The first direct objective of Maker Education and the Maker Movement is to stimulate and promote so-called “Maker Skills”, i.e., the capacity of creating something. [8] Following Bandura (1977), we asked the participants to self-report their self-efficacy in this respect. Self-efficacy can be understood as a person’s confidence in their own ability to perform a specific task. For Making Skills, we used three items: (1) How good are you with making things with locally available materials? (2) How good are you with providing new services for the local market? and (3) How is your capability to invent and design new products or services?
- 3) **Social engagement (SE):** The Maker Movement highlights the importance of the community’s role in advancing goals and outcomes. This makes it appropriate to measure changes in how participants perceive the role of their work in relation to the community. The study uses Grant’s (2008) [18] 4-item instrument to measure changes in prosocial motivation.
- 4) **Academic performance (AP):** Increased exposure to maker activities may impact student’s interest in studying and pursuing similar subjects. The research asks students about their favorite subjects and sees if there are changes for preference towards science, technology, engineering, arts, and mathematics (STEAM) courses after exposure to maker education. Furthermore, attitudes related to learning goal orientation and learning from errors are measured using VandeWalle’s (1997) and Rybowiak, Garst, Frese, and Batinic’s (1999) respective instruments to measure change in overall learning attitudes in line with maker education learning principles. 4 Lastly, school grades from STEAM-related subjects are gathered to support analysis.

#### C. RESEARCH MODEL

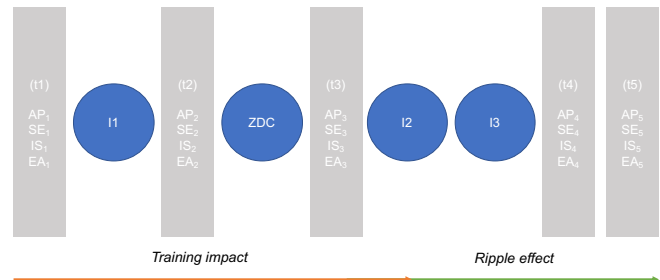


Figure 2. Guiding research model

The operating model of the research adapts a longitudinal approach that staggers data collection across 5 time periods:

- 1) T1 – baseline survey for all groups (*completed*)

- 2) T2 – post-training survey immediately after intervention 1 (I1) workshop for treatment group (*completed*)
- 3) T3 – post-training survey administered after a series of design workshop challenges
- 4) T4 – post-training survey administered one month after I3
- 5) T5 – post-training survey administered six months after I3

### INITIAL FINDINGS

We performed preliminary data analyses on the T1 and T2 data collected among the treatment group. Responses from 58 participants were collected; and conducted a paired t-test to assess the immediate impact of the Maker Training intervention. The average age of workshop participants is 14, with the youngest being 13, and oldest 15 years old. Of the 58 participants, 34 are female. Table 1 shows that two of the three effects analyzed are statistically significant increases.

*Table 1. Paired T-Tests for Impact on EA, IS, and SE*

	T1	T2	Change	Paired t-test	p
<b>IS</b>	3.470 (.982)	3.7917 (.950)	0.3220	-2.955	<.001
<b>EA</b>	5.03125 (1.075)	5.34375 (1.142)	0.313	-2.289	0.026
<b>SE</b>	5.953 (1.002)	6.086 (.985)		-1.358	0.180

Indicators of both the self-confidence in Maker-Skills (IS) and Entrepreneurial identity (EA) were significantly higher after the Maker Training intervention, whereas social engagement did not change much. Initial analysis also explored the effect of gender. These tests found no significant difference between outcomes of male and female participants.

### RESEARCH CONTRIBUTIONS

The paper is one of the first quantitative studies focused on the impact of the Maker Movement as an alternative EET to serve as a platform to engage a broader and significantly younger audience. The study creates a conceptual guide for future research focused on maker education. This contributes to the literature on entrepreneurship development by building on sparse evidence that focuses on latent entrepreneurs. The research also builds the theory of pre-entrepreneurship as a phase that is closely linked to latent entrepreneurship and equally important, and where seeds of entrepreneurial career options are being planted in the minds of youngsters.

Findings have significant implications for educational institutions with strong interest to enhance the entrepreneurial qualities of their students. This is also relevant for governments, especially those afflicted with challenges linked to inequality, to learn from a more inclusive process that enables them to mobilize individuals who are not specifically considering entrepreneurship, to learn life-skills that are relevant to an increasingly disrupted labor market.

### NEXT STEPS FOR RESEARCH

The initial workshop for the program only recently concluded and post-test surveys are currently being adminis-

tered. The following action points guide the next steps of the research for the next two months:

- 1) Implementation of high school level maker workshops parallel to the ZDC.
- 2) Recent interventions include the implementation of the program in India hence there is opportunity to compare cohorts of students across cultures and contexts will be an interesting area of exploration moving forward.

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