BACKGROUND NOTE

Incubating Future Innovators and Entrepreneurs

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INCUBATING FUTURE INNOVATORS AND ENTREPRENEURS[1]

Experiments in Underserved Communities

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Innovators and entrepreneurs create jobs, generate wealth, solve problems, and transform their communities. More and more governments and development institutions around the world recognize innovation and entrepreneurship as an important ingredient to prosperous economic growth. While innovative technologies, such as blockchain, disrupt the way organizations and governments operate, the impact of innovation-driven enterprises on job creation and wealth distribution attract investments to facilitate and strengthen better innovation and entrepreneurship related outcomes.[2] This trend is especially true against the backdrop of a knowledge-driven economy that disrupts business-as-usual approaches. Human capital development related to innovation and entrepreneurship is becoming more important, with an emphasis on skills relevant to future labor market dynamics.

With the increasing importance of innovation and entrepreneurship skills, the question then becomes, how do we build the innovation and entrepreneurship human capital of populations?

A. How Innovation and Entrepreneurship is Currently Nurtured

Entrepreneurship education and training (EET) is often the most common learning approach used to attain better innovation and entrepreneurship human capital outcomes. EET refers to programmatic interventions that aim to impart entrepreneurial knowledge, skills, and attitudes for its participants. A review reveals that current EET programs are often designed for nascent and active entrepreneurs, most of whom already possess sufficient levels of innovation and entrepreneurship human capital to conduct innovation

[1] The authors acknowledge institutional support from the Asian Development Bank with special thanks to Elisabetta Gentile and Kirsty Newman for providing feedback that greatly helped shape this paper's conceptual approach.

[2] T. Aste, P. Tasca, and T. Di Matteo. 2017. Blockchain technologies: The foreseeable impact on society and industry. *Computer*, *50*(9), pp. 18–28. D. Audretsch and M. Fritsch. 2003. Linking entrepreneurship to growth: The case of West Germany. *Industry and Innovation*, *10*(1), pp. 65–73.; and G. George, A.M. McGahan, and J. Prabhu. 2012. Innovation for Inclusive Growth: Towards a Theoretical Framework and a Research Agenda. *Journal of Management Studies. 49, (4),* pp. 661–683.

and entrepreneurship -related activities.[3] This focus, however, excludes a significant proportion of the existing population who have no clear intention (yet) to learn innovation and entrepreneurship related skills but are equally capable future innovators and entrepreneurs. Our experience tells us that targeting the few existing entrepreneurs does not help scale the growth of innovation and entrepreneurship fast. Also, adults often face social pressures and expectations of stability that pull them more toward stable jobs than entrepreneurship. Hence to scale up the population of innovation and entrepreneurships, we need to target school children since they have several years to build their skills before becoming adults and have less fear of learning new things or failing. This formative window is an untapped opportunity, especially for countries with younger populations (i.e., often developing countries) that can benefit from maximizing the innovation and entrepreneurship potentials of its working population. Shifting the focus of EETs, however, is not a simple process. Significant changes to content and delivery are needed to make these interventions appropriate for uninitiated individuals. Training this group of individuals earlier could provide a significant feedstock to the next phase of EET programs.

In this respect, initiatives that build on studies by Athayde (2009) and Gohmann (2012) on latent entrepreneurship leads us to believe that there is a critical step between latent and nascent entrepreneurship that will be valuable for institutions interested in innovation and entrepreneurship human capital outcomes. "Pre-entrepreneurs" are individuals who have built innovation skills such as creativity, divergent thinking and problem solving, and entrepreneurship attitudes such as self-efficacy, self-learning, and the ability to see problems as opportunities. They are the ideal candidates for EET programs. They are ideal candidates for EET programs. Figure 1 shows how we situate the concept of pre-entrepreneurs.

B. Maker Education and Training as an Alternative Approach to Entrepreneurship Education and Trainings

Skills that can be applied in future learning opportunities help facilitate better outcomes.[4] This highlights one's ability to apply past lessons and skills in different contexts. Conducting EETs for nascent and active entrepreneurs is appropriate given their context. Creating the "pre-entrepreneurs" from the general population with unrealized innovation and entrepreneurship abilities require a treatment different from current innovation and entrepreneurship training because this uninitiated group does not yet possess foundational skills immediately relevant to innovation and entrepreneurship. To engage this much broader population to the Maker Movement experience, where learning creative and technical skills outside their current competence through an experience-based program, is proposed as an alternate and contextually nearer learning approach.

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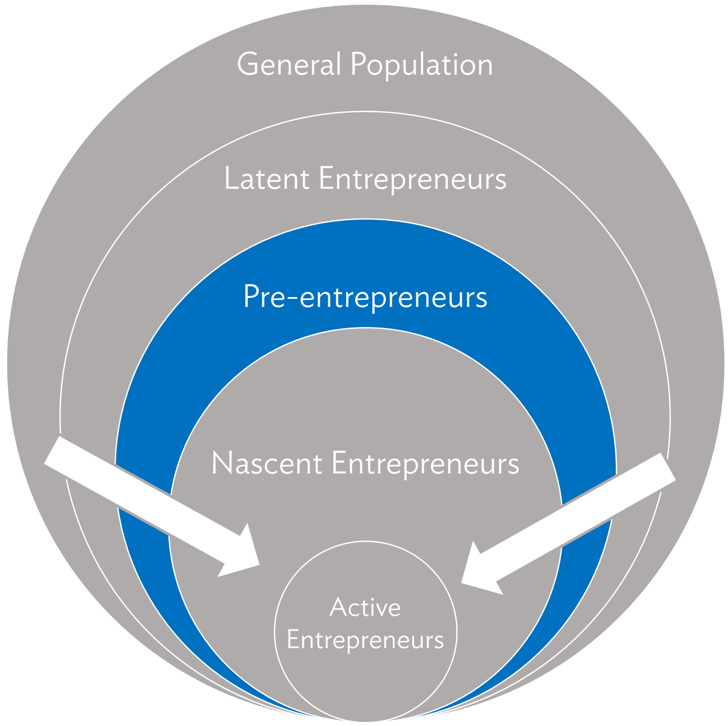
[3] B. Martin, J. McNally, and M. Kay. 2013. Examining the formation of human capital in Entrepreneurship: A Meta-Analysis of Entrepreneurship Education Outcomes. *Journal of Business Venturing, 28*(2), pp. 211–224,

[4] R. E. Haskell. 2001. A Vol. in the educational psychology series. Transfer of learning: Cognition, instruction, and reasoning. San Diego, CA, US; and G. J. Calais. 2006. Haskell's taxonomies of transfer of learning: Implications for classroom instruction. In National Forum of Applied Educational Research Journal (Vol. 20, No. 3, pp. 1–8).

Figure 1: Situating Pre-entrepreneurs



Source: Nair, R., J.E. Corpus, M. Frese, and W. Smit. 2019. Maker Education as an Early Intervention to Catalyze the Development of Pre-entrepreneurs in Underserved Communities. (Presented in: International Symposium on Academic Makerspaces.) In conference proceedings.

There are three important components to the Maker Movement:

(i) technology referring to hardware tools (e.g., 3D printers) that allow design and fabrication;

(ii) community, referring to the maker, hackers, and mentors who collaborate and share ideas, technologies, and designs with each other to reinforce a maker culture; and

(iii) space, referring to a physical set-up where a community can collaborate - these are sometimes called makerspaces and fabrication (fab) labs.[5] Maker Movements rapidly accelerate the act of "making" artifacts through collaboration, rapid prototyping, and learning by doing. The act of making is defined as:

"Constructing activities and related ways to fabricate real or digital things using technological resources, including fabrication, physical computing, and

[5] R. E. Browder, H. E., Aldrich, and S. W. Bradley. 2017. Entrepreneurship research, makers, and the maker movement. In *Academy of Management Proceedings* (Vol. 2017, No. 1, p. 14361). Briarcliff Manor, NY 10510: Academy of Management (January).

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."[6]

Technology, community, and space serve as the foundations of the Maker Movement and allow for better accessibility to the process of making. As individuals create gadgets for fun as Makers and gradually learn to develop products and solutions as Innovators that are useful to their immediate environments to address specific needs, applying these lessons to create and capture value leads to future entrepreneurial activities as a natural transition.[7] The Maker Movement is an alternative approach to EETs that engages a broader audience who have no prior experience nor intention to enter into entrepreneurial pathways.

While the Maker Movement can serve different purposes, this paper looks at Maker Spaces as a platform to nurture future innovators and entrepreneurs.

Experiment 1: Maker Education and Training in Underserved Universities in Rural India[a]

A series of Maker Education and Training workshops were conducted in rural parts of India back in 2014. The first intervention was conducted at Mar Baselios College of Engineering and Technology (MBCET) in Trivandrum, Kerala State. The college was chosen because Trivandrum is significantly smaller than other major Indian metropolises, and the college itself is not one of the nation's top tier academic institutions. The second workshop for eighteen days focused on the local industries and rural problems in Shri Ram Group of Colleges in Muzaffarnagar, Uttar Pradesh. This college saw its first graduating batch in the summer of 2014. The population of Trivandrum is 1 million, and that of Muzaffarnagar is about 500,000; in comparison, the population of other major cities in India varies from 5 million to 13 million.

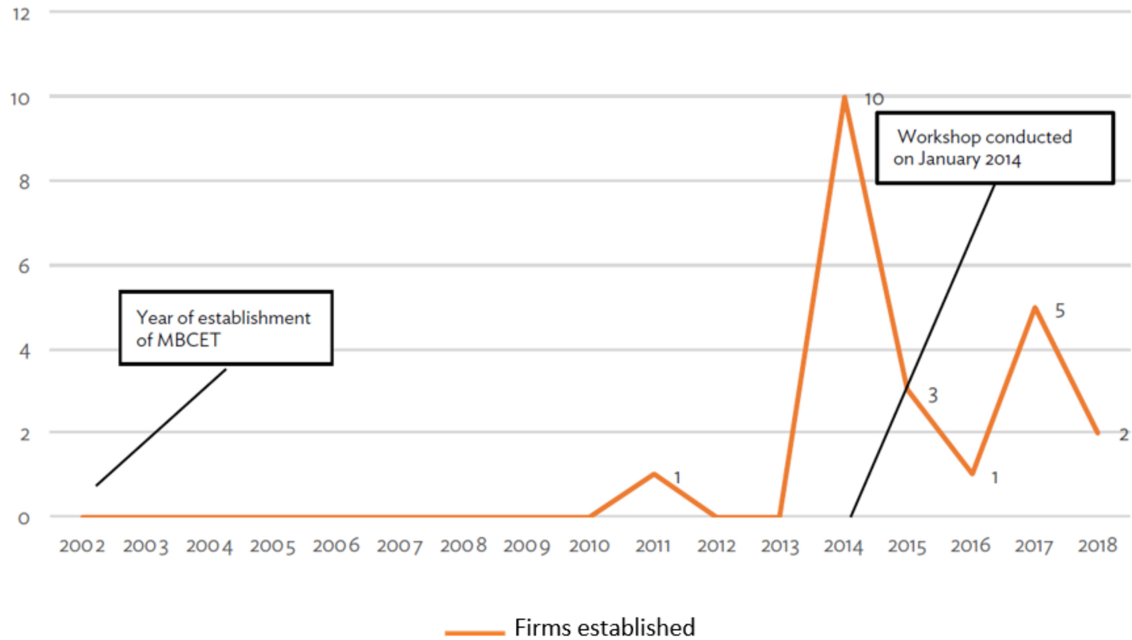
In the workshop, innovation and entrepreneurship concepts were broken down as students learned to identify and evaluate problems/ and opportunities with societal impact and financial gain, design and make products, and develop and pitch business plans. This process was repeated to build team chemistry and confidence in the innovation process and their entrepreneurial capabilities—an attempt to develop foundational soft skills that are relevant to entrepreneurship and employment pathways. While participants initially had difficulty participating in an unstructured workshop approach, continuous iteration complemented with an emphasis on "learning by doing" approach encouraged them to keep trying.

Tests were administered before and after each workshop and another tracer study administered in 2018. Each test measured three main variables: (i) self-efficacy in maker skills, (ii) entrepreneurial self-efficacy, and (iii) intention to create a new business (BI). Our analysis showed positive outcomes across all three dimensions. More interestingly, we found that individuals who displayed *high-advocacy behaviors* (i.e., activities of continued participation and sharing of innovation and entrepreneurship workshops) reflected higher and sustained outcomes among participants.

[6] S. Papavlasopoulou, M. N. Giannakos, and L. Jaccheri. 2017. Empirical studies on the Maker Movement, a promising approach to learning: A literature review. *Entertainment Computing*, *18*, pp. 57–78.
[7] R. E. Browder, H. E. Aldrich, and S. W. Bradley. 2019. The emergence of the maker movement: Implications for entrepreneurship research. *Journal of Business Venturing*, *34*(3), pp. 459–476.

A recent follow-up with one of the schools mapped out entrepreneurial activity in MBCET since its establishment and workshop participants' interaction with the larger academic community (Figure 2). On the firm level, 10 businesses were set up immediately following the workshop in 2014 with more established until 2018.

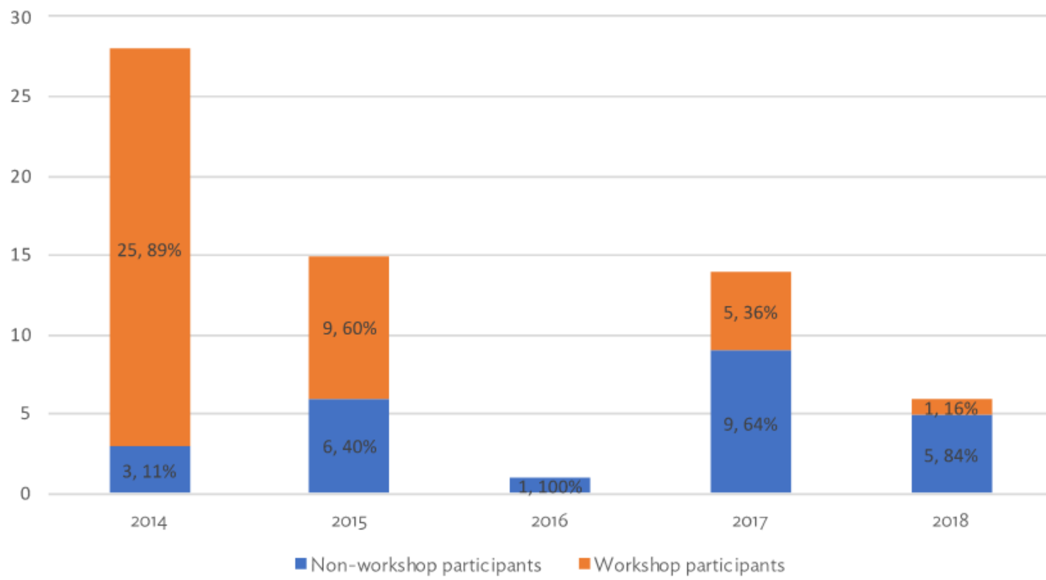
Figure 2: Entrepreneurial Activity in MBCET (firm level)



Source: Nair, Smit, and Corpus. 2018.

Figure 3 shows that workshop participants from MBCET (orange bar) recruited their non-workshop peers (blue bar) as co-owners of firms. Entrepreneurial activity among non-workshop participants within firms established increased overtime, indicating an infection effect that is the subject of future studies. Even though some of the companies that were started eventually closed, the same entrepreneurs started new ventures that included more non-participants. Many of the initial fifty participants, in effect, created an ecosystem that attracted many non-participants to create 25 startups in four years in a college that had no student entrepreneurship activity before the intervention. Today, well after the original participants have graduated, the ecosystem in the campus is still thriving and growing.

Figure 3: Entrepreneurial activity among firms established by MBCET (individual level)



Source: Nair, Smit, and Corpus. 2018.

Reference:

Nair, J., W. Smit, and J. Corpus. 2018. The Ripple Effect of Maker-Training in Rural Communities: A Longitudinal Study on the Impact from Innovation & Entrepreneurship Training Intervention on University Students. (Presented in: Asia Innovation and Entrepreneurship Association-National Bureau of Economic Research Conference). Working Paper.

The workshop experience illustrated in Box 1 is consistent with the theories that:

(i) Maker education and training is an alternative approach to attain innovation and entrepreneurship outcomes;

(ii) there is space to engage an even younger audience to conduct early adolescent interventions to nurture foundational soft skills relevant to IE; and

(iii) the workshop approach can be refined to create a self-reinforcing community-driven platform to build a community of innovators and entrepreneurs.

Our data suggest that our interventions were effective in increasing self-efficacy and intention towards innovation and entrepreneurship activities. Further, we learned that even though teaching technical skills was manageable for university students, inculcating foundational soft skills relevant to innovation and entrepreneurship was significantly more difficult. Jumping to problem-solving (innovation) and value creation (entrepreneurship) lessons without the foundational soft skills such as creativity and learning orientation (among others) were significant learning barriers. Governments and development institutions need to reshape their engagement strategy of adolescents if they genuinely want to build innovation and entrepreneurship human capital among its labor force. The foundational assets that are relevant to successful innovators and entrepreneurs must be nurtured significantly earlier than currently done.

Heightened outcomes among participants who displayed higher-advocacy activities are encouraging and aligned with the hypothesis that maker education and training is a realistic alternative to EETs. The workshop framework was, therefore, refined and formalized in an attempt to establish a replicable and scalable maker-based education and training approach.

C. Building a Community of Future Innovators and Pre-entrepreneurs

The Zero to Entrepreneur (Z2E) framework that was developed at Massachusetts Institute of Technology and tested at the initial India intervention mentioned in Experiment 1 breaks down the developmental phases of an innovation-driven entrepreneur. Since then, the Z2E learning methodology was further shaped over 50 workshops conducted in seven countries for more than 2,500 learners. This model focuses on five key stages of innovation and entrepreneurship development:

(i) **Zero**: the majority of uninitiated youth, with unrecognized potential, pursuing an ostensibly steady job.

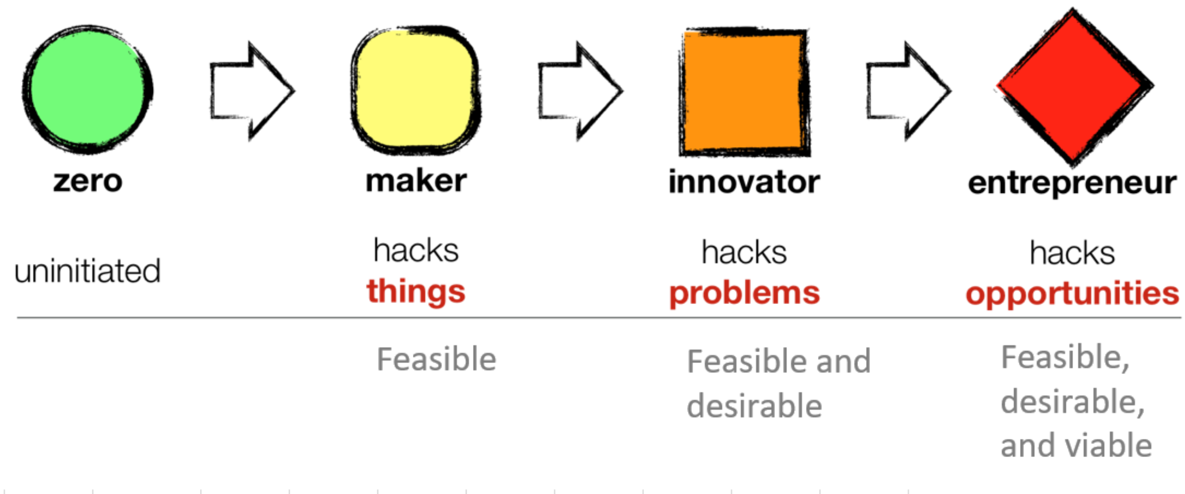
(ii) **Maker**: the creative thinker and doer, one who thinks outside safe spaces, connects disparate ideas, and designs and makes things.

(iii) **Innovator**: a problem solver who can synthesize observations and interactions to identify unmet community or human needs, and create and validate desirable solutions for social impact or financial gain.

(iv) **Entrepreneur**: the value creator who converts a problem into a commercial opportunity through creating an organization, a team, suppliers, and sales channels, all from resources that she did not possess.

(v) **Ecosystem**: building a vibrant community, consisting of makers to entrepreneurs as role models and mentors, that attracts new candidates and nurtures them through their developmental process of becoming a pre-entrepreneur.

Figure 4: The Zero to Entrepreneur Framework



Source: Nair, R., W. Smit, J Corpus. 2019. The Ripple Effect of Maker-Training Impact: A Longitudinal Study among Young Latent Entrepreneurs in Rural India. (Presented at FAB15 Conference on Fabrication, 2019).

Similarly, curricula must be revisited by governments and learning institutions to ensure that a progressive and structured learning experience does not shock or frustrate learners to the point of deterrence. The Z2E approach, for example, staggers learning progression and introduces nonlinear practices that strengthen foundational soft skills in the process. It takes the student through controlled failures and learning to build confidence to handle unfamiliar challenges. In schools, Maker Education and Training are currently used to provide a natural bridge to understand how science, technology, engineering, arts, and mathematics (STEAM) related theories work. Exposure to digital fabrication tools and design related challenges is a practical application to STEAM theories learned inside classrooms. Designing such complementary education and training approaches (e.g., blended learning) that facilitate practical learning opportunities will be increasingly important.

Governments must resist the temptation of skipping necessary and progressive steps towards innovation and entrepreneurship human capital outcomes. Interventions that similarly wish to promote innovation and entrepreneurship will greatly benefit from breaking down relevant concepts into bite-sized pieces conscious of the natural learning progression of innovators and entrepreneurs alike.

D. Cultivating Innovation and Entrepreneurship Should Start Younger, Requiring Significant Content and Pedagogical Changes in Education and Training Approaches

It is well established that EET content mainly focuses on technical business concepts such as human resource management, marketing strategies, financial management, and value chain operations. Moreover, the delivery of EETs is focused on pedagogical methodologies appropriate for experienced and more mature audiences, often through highly structured education and training programs such as formal degrees, competitions and hackathons, and intensive short courses, among others. Governments and development institutions that wish to build innovation and entrepreneurship human capital need to reshape the approach, appropriate for an uninitiated younger audience. Our experience in implementing such a program for underserved communities in Kedah, Malaysia, exemplifies just that.

Experiment 2: Early Intervention on Innovation and Entrepreneurship among Uninitiated Adolescents in Kedah, Malaysia[a]

A 6-month engagement launched in the state of Kedah, Malaysia envisions a community of young adolescents to lead innovation and entrepreneurship from within their communities. Consistent with the pillars of the maker movement, the intervention provides a $3,000 maker lab that contains necessary equipment and materials to build a lab that can support 50 students. This lab (consisting of 3D printer, electronic controllers, input-output devices such as sensors, motors, displays, and wireless communication modules, hand and power tools, and consumables) provided for free for each participating secondary school, with the condition that they will find an accessible space within school grounds for activities to be conducted—addressing the space and tools components of the Maker Movement. A three-day innovation and entrepreneurship focused workshop kicks off this engagement to support the community pillar, which imparts relevant knowledge, skills, and attitudes for young people who are deep-diving into the world of innovation and entrepreneurship for the first time. Workshops are done for 10 secondary schools with six students and two teachers participating as representatives from each school. Schools selected are situated within the bottom 40%[b] (B40) communities. The series of workshops focus on basic ideation, design, fabrication, electronics, coding, movie making, and presentation opportunities.

The workshop focused on the first part of the Zero to Entrepreneur framework, introducing innovation and entrepreneurship concepts that are aimed at enhancing the **creative efficacy and competency** of participants, encouraging the cohort to think outside the box through **design thinking** approaches. The focus of this intervention is to impart key concepts, lessons, and concrete learning experiences that provide opportunities to build foundational human capital relevant to innovation and entrepreneurship on a level that is appropriate to an uninitiated audience as the Zero to Maker phase. This phase was further disaggregated across three learning stages implemented in the workshop:

(i) Stage 1 primarily is a hands-on workshop focused on mini-projects that allowed each group to develop teamwork and understand the concepts of physical and system design, and coding. Lessons from the three subcomponents help them accomplish the final challenge, which is to build a “traditional game with intelligence” as freely conceived by them using the tools made available to them.

(ii) Stage 2 consisted of providing mentorship, online, and onsite, to the students to kickstart design activities and advocacy behavior to attract new students. An online discussion platform helped students from different schools to interact with each other, and further build their mentorship activities. They designed and fabricated electronic products every 2 months with computer-aided design tools, 3D printer, Arduino controllers with peripheral devices programmed to work as a system.

(iii) Stage 3 is an event where multiple teams from each of these schools compete in a design challenge 6 months after the initial intervention. Multiple designs and making activities during this period builds momentum in building local ecosystems in these schools that sustain and grow with minimum external intervention.

Moreover, the learning pedagogy was decomposed to make it unstructured—transferring the responsibility to the younger cohort. Examples of these learning principles are:

(i) **Problem-based learning.** The workshop structure allows for a dynamic pedagogical approach where participants gain knowledge and skills by working on design challenges over a period of time.

(ii) **Hands-on learning.** After each technical concept was taught, participants always had an opportunity to apply it and learn it in context immediately. This is a necessary adjustment to make, especially for younger cohorts, who learn more through concrete experiences.

(iii) **Collaborative learning.** The workshop moved away from the traditional teacher-student relationship and placed the burden of learning on participants as teams and individuals. Students learned to work together and use the internet to learn new subjects on their own and started applying this skill in their academic disciplines.

Initial results from pre- and post- surveys showed significant changes in Maker skills and Entrepreneurial Identity among participants. Recent visits to each school also revealed high advocacy activities among workshop participants, who are beginning to engage classmates and friends as well to grow the community ten-fold in a few months.

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[a] Nair, R. J. E. Corpus, M. Frese, and W. Smit. 2019. Maker Education as an Early Intervention to Catalyze the Development of Pre-entrepreneurs in Underserved Communities. (Presented in: International Symposium on Academic Makerspaces). In conference proceedings.

[b] Refers to households who have a median household income of RM3,000 and a mean household income of RM2,848.

This experience allowed us to test the Z2E framework further, engaging adolescents instead of youth, through secondary schools. We learned three key insights given the new engagement arrangement: (i) Scoping the purpose of a Maker Space is important since this allowed us to curate a more flexible, purposive, and cost-effective arrangement to address a common critique of Maker Spaces, often cited as too expensive. From the very beginning, stakeholders must be aligned on what human capital outcomes are envisaged. (ii) Securing an area within each school to be a designated Maker Space is an important component to a sustainable approach in nurturing innovation and entrepreneurship human capital among adolescents. Governments can play a role in aligning resources to its intended educational outcomes, including this aspect. (iii) Even adolescents can become champions of innovation and entrepreneurship in secondary schools, as evidenced by increased activity in pilot schools that are led by original workshop participants.

Building on this experience, we also learned that there is an opportunity to develop affordable, scalable maker spaces that can deliver intended innovation and entrepreneurship human capital outcomes. Experiment 3 below outlines the initial process of how governments and development institutions who are interested in alternatives to EET can curate and organize their maker education and training aligned to the overarching desired outcomes at a fraction of the cost.

Experiment 3: Building Scalable Makerspaces for Affordability and Reach[a]

Makerspaces are central to building Makers and future entrepreneurs. However, most communities cannot afford expensive makerspaces. Creating purpose-driven makerspaces that are affordable and impactful is necessary for scaling such initiatives across a broader audience.
Three kinds of Makerspaces were conceived and tested out in different contexts:

(i) **Zero lab**. Students learn to use discarded materials such as newspapers, plastic bottles, and ropes to build products that can teach them basic Science, Technology, Engineering, and Mathematics concepts. In workshops held in India and Indonesia, these projects focused on science topics such as 'Static forces' where they built towers from tubes made of newspaper to learn stress and reinforcement, or where they built wind and string musical instruments to learn vibration, sound, and octaves.

(ii) **Mini lab.** Kits consisting of motors, wheels, screwdrivers, soldering iron, wires, and power adapter costing \$20–\$100 were distributed in village centers in Gujarat, India, and adult mentors were trained on creating simple powered robots. These mentors taught the same to children in the village, and they created robots to play football on a simulated court. Such gamified events attracted young students who showed great interest in building further with help from local carpenters and bicycle repair techs.

(iii) **Maker lab in a box.** The lab mentioned in Experiment 2 was conceived as an extension of this program to reach schools where space could be provided to nurture a maker ecosystem. This lab is envisioned to be customizable and easy to distribute laboratory provided for learning institutions, particularly those who come from underserved communities.

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[a] Case study based on: D. Saidava, T, Betai, and R. Nair. Scalable Makerspaces in Rural Community for Creating Sustainable Ecosystem in Developing Countries. (Presented in: International Symposium on Academic Makerspaces,2019). In conference proceedings.

Key Messages

1. **Unlock pre-entrepreneurship potential.** Current methods for innovation and entrepreneurship development are limited to nascent entrepreneurs in selected communities, and the larger population of youth with equal potential do not get included. 'Pre-entrepreneurship' is the access way to innovation and entrepreneurship development that could reach school-age students and can be scaled into underserved communities, given its focus on building foundational skills.
2. **Make learning holistic and fun.** It is essential to build foundational soft skills such as creativity and learning orientation (among others) to facilitate better learning outcomes in problem-solving (innovation) and value creation (entrepreneurship) lessons. Such interventions can lead not only to the creation of future innovators and entrepreneurs but also makes a better employable generation that learns to apply their school learning and foundational skills necessary for tomorrow's employment.
3. **Stay focused on long-term ecosystem building.** Governments must resist the temptation of skipping necessary and progressive steps towards innovation and entrepreneurship human capital outcomes hoping for faster results and implement tested methodologies that may take a longer incubation of future innovators and entrepreneurs. Interventions that similarly wish to promote innovation and entrepreneurship will greatly benefit from breaking down relevant concepts into bite-sized pieces conscious of the natural learning progression of innovators and entrepreneurs alike.