The MIT SUD Ventures Program: Entrepreneurship Training for Researchers in STEM and Beyond

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***Abstract*—This innovative research paper presents a program that introduces entrepreneurship, innovation, and biomedical product development to engineering, computer science, and other STEM and non-STEM professionals to engage them into startup creation with the goals of preventing, diagnosing or treating substance use disorder (SUD), one of the US most pressing health and social challenges.**

For more than two decades, SUD has been affecting people from all ages, demographic and socio-economic groups in the US. The National Institute on Drug Abuse (NIDA), as the lead federal agency supporting scientific research on drug use, has identified that current SUD research is not properly translating into commercial solutions for SUD. Seeking alternatives, NIDA is fostering the entrepreneurial spirit of SUD researchers, so they are the ones directly offering SUD-focused technologies into the market.

This paper presents the MIT SUD Ventures program, a NIDA-funded project focused on training multidisciplinary teams of SUD researchers, engineers, healthcare, and management experts on how to commercialize their discoveries with the support of government funding sources. We introduce the learner profile, the content and skills deemed necessary to support their entrepreneurial efforts, the curriculum implemented and the program structure. We share results related to the learner expectations, experiences, and outcomes of this innovative practice, as well as future steps for the 2024 cohort and impact evaluation. Finally, guided by our results, we discuss the positive value of teaching entrepreneurial skills to academics and researchers to bridge the gaps between basic and translational research.

We also make a call for action for all STEM professionals, especially engineers, computer scientists and technologists, to employ their scholarship and research capacity to have a positive impact on solving the SUD epidemic, where they are most needed.

Keywords—challenge-based instruction, continuing education, entrepreneurship, innovation, learning communities, substance use disorder

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I. INTRODUCTION

A. Substance use disorder and addiction

Substance use disorder (SUD) is a clinical diagnosis via the Diagnostic and Statistical Manual of Mental Disorders 5, Text Revision (DSM-5-TR) [1]. The DSM-5-TR defines substance use disorder as "*a constellation of behaviors involved in compulsive drug seeking including impaired control of substance use, impaired social interactions with others because of substance use, risky drug use (e.g., substance use in hazardous settings), and pharmacological changes (e.g., experiencing withdrawal symptoms)*" [1,2]. The DSM-5-TR defines *addiction* as the *"most severe, chronic stage of the SUD diagnosis, which is characterized by substantial loss of self-control, manifesting in compulsive drug-seeking behavior despite the desire to discontinue use"* [1-3]. Addiction is a chronic disease and repeated substance use can lead to brain changes that can be persistent, and often permanent. For this reason, substance use is considered a "relapsing," "recurrent" or "chronic" disease [4]. *Addiction leads to anatomical and physiological brain changes* that an individual must cope with, and seek treatment for, for the rest of their life.

SUD and addiction are a significant global public health challenge. In the US alone, between 1999 and 2021, more than 1 million people died from drug overdose [5]. In 2021, 46.3 million (16.5% of the population 12 years and older) were diagnosed with SUD and nearly 108,000 died [6, 7]. People from all ages, genders, demographic groups, and educational levels suffer with SUD. In 2020, approximately 59 newborns were diagnosed every day with Neonatal Abstinence Syndrome (NAS): a form of SUD affecting children of pregnant women suffering SUD, one every 29 minutes, a figure that increased by 82% from 2010 to 2017 [8]. In the workforce, there has been a 5-fold increase in overdose deaths at work in less than a decade (with 388 in 2020) [9]. These numbers reflect the socio-economic toll and the tragedies endured by families and communities struggling to uproot SUD from their lives.

B. SUD is a health issue, not a personal or lifestyle choice

The likelihood of someone developing a SUD can be affected by the interplay of genetic and environmental factors. It is not a simple personal choice or lifestyle but the result of

complex interactions. *Social determinants of health* (i.e. systemic factors within a home, family or community that impact one's health outcomes) can lead to the development of a SUD. These social determinants intersect at the societal, community, interpersonal, and individual level (also known as the *Social-Ecological Model -SEM- of Substance Use*) and regulate an individual's likelihood of first trying and then continuing to use substances, as seen in Table I [10].

TABLE I. SOCIAL-ECOLOGICAL MODEL OF SUBSTANCE USE FACTORS [a]

SEM Levels	Factors
Societal	Stigma, available housing, legislation, incarceration.
Community	Proximity/access to treatment, public health messaging, availability of naloxone or opioid replacement therapy.
Interpersonal	Family or living situations, support systems available.
Individual	Biology/genetic predisposition (accounts for about ½ a person's risk of developing a SUD), other mental health disorders (comorbidities).

[a.] Taken from https://www.health.state.mn.us/communities/opioids/prevention/socialdeterminants.html

These are important considerations when contemplating the erroneous idea that individuals who use substances lack moral principles or willpower and that they could stop use simply by choosing to do so. *SUD is a complex brain disorder* that affects multiple organs, specially the decision-making center in the prefrontal cortex of the brain. Quitting or controlling substance use takes more than a strong will and good intentions. This is a deeply rooted societal stigma that needs to be debunked. The use of addictive substances changes the anatomy and physiology of the brain in ways that make quitting hard, even for individuals who desire to quit [4]. For all these reasons SUD poses an enormous challenge that requires the engagement of governments, academia, civil society, and private companies.

C. The role of NIDA

The National Institute on Drug Abuse (NIDA), as the lead federal agency supporting scientific research on drug use, has invested more than USD$1,5 billion per year in the last decade towards solutions for SUD [11]. Despite these efforts, the current scientific and technical investments are not properly translating into commercial solutions for the prevention, diagnosis, and treatment of this devastating disorder.

Seeking innovative alternatives, NIDA has proposed novel approaches to motivate and educate SUD researchers into commercializing scientifically sound SUD-focused technologies. NIDA has put together different strategies to bridge the gap between basic and translational research, and to move discoveries from the lab into the market. Table II presents some of the federal government funding and training programs available to support SUD product development and financing.

As part of these efforts, in 2022 NIDA and the Massachusetts Institute of Technology (MIT) signed a cooperative agreement to develop and implement an educational program to train SUD researchers in entrepreneurship and biomedical product development.

II. THE MIT SUD VENTURES PROGRAM

In 2022, MIT, via Open Learning, engaged into a 5-year cooperation agreement with NIDA to carry out the MIT SUD Ventures program for 4 cohorts of learners (one per year), who will receive training funded by NIDA, free of charge. The program's overarching goal is to advance the inception and development of products and services to offer, scale, and deliver effective prevention, diagnostic and treatment solutions for SUD. This will be achieved by training SUD researchers in entrepreneurial problem solving, innovation, and biomedical product development following the following core principles:

- Combine entrepreneurship, SUD, and education scholarship to create a multidisciplinary curriculum.
- Develop a curriculum based on a careful, evidence-based needs assessment focused on the population to be trained and NIDA's goals.
- Include coaches with experience in research, industry, and entrepreneurial innovation to support the educational activities and learning journey.
- Foster and support a community of peers to connect learners with experts in multidisciplinary fields, cross-pollinate ideas and provide mutual support.

TABLE II. RESOURCES FOR SUD PRODUCT DEVELOPMENT, TRAINING AND FINANCING [b]

Stage	Goal	Funding and training programs
Stage 1	Basic and applied research	NIH SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer), Blueprint Neurotherapeutics Network (BPN), Blueprint MedTech (BPMT)
Stage 2	Identification of viable product	NIDA Entrepreneurship Schools, NIDA Start A Startup Challenge
Stage 3	Testing and prototyping	NIH SBIR and STTR
Stage 4	Customer portfolio	NSF I-Corps, Technical And Business Assistance (TABA).
Stages 4, 5, 6	First and second expansion of customer base	NIH phase III SBIR and STTR, SAMHSA Prevention Grants Program, SAMHSA Substance Abuse Prevention and Treatment Block Grant (SABG), Medicaid , State Opioid Response Grants (SOR), Opioid settlement moneys, Opioid Recovery and Remediation Funds

[b.] This is not an exhaustive list, for more information see [12]

A. The needs assessment evaluation

Prior to the curriculum development, two education researchers carried out a needs assessment study to understand the tentative participants' expectations and entrepreneurial experience, and the academic factors (pedagogy, content, and technology) that better fit their needs and capabilities.

The researchers aimed to unveil factors that would motivate or challenge the learners to shift from lab research to business development, and understand the realities of the learners' work, their expectations regarding entrepreneurship and biomedical product development, and the facilitating and challenging factors toward entrepreneurship training.

The needs assessment also sought the appropriate learner profile to fulfill NIDA's goals. Although NIDA expressed an understanding of the reasons for such an educational program,

it's focus, and initial curricular topics of interest, the MIT team employed the needs assessment to delve deeper into the SUD researchers' needs for, and perception on, startup creation to better support them in this endeavor and tackle the root causes for the disconnect between research and commercialization: only via a needs assessment a true tailored content could be created.

Between October 2022 and May 2023, the education researchers performed online interviews to 22 SUD and engineering researchers, professors, entrepreneurs, and other people deemed aligned with the learner profile. Interviewees were deans of research, early career and senior faculty and researchers, entrepreneurs in the field of SUD, STEM, and related areas. Their fields of work spanned from chemistry, behavioral neuroscience, psychology, public health, computer science, biomedical engineering, and business. Healthcare startup founders and CEOs were also interviewed, with a range of qualifications such as MBA, and MD. Table III summarizes the main lessons learned from the discussions with the interviewees.

TABLE III. LESSONS LEARNED FROM NEEDS ASSESSMENT [c]

Topic	Description
Multidisciplinary expertise in founders	Startup founders benefit from having expertise not just in SUD, but also management, engineering, healthcare marketing and sales. This ensures startup sustainability, and background diversity promotes innovation.
Risk reduction	Startup creation comes with a high level of real and perceived risk. It is key to distribute this risk by including as founders qualified experts in all needed domains, providing key entrepreneurship training, and offering a support network.
Create a community of peers	The proposed program requires creating the right network of professionals interested in SUD solutions and entrepreneurship, and foster opportunities between founders and 1) domain experts in business and management, marketing, finance, fundraising, and government grants; 2) corporate sector (VC, angel investors); 3) experts in policy, healthcare regulation, intellectual property and legal topics; 4) SUD patient and family organizations; 5) vendors, research organizations and service providers for FDA, IND (investigational new drug), IDE (investigational device exemption), premarket approval (PMA), regulation and compliance studies.
Present program's academic gains	Any program offered must fit the researcher's time availability and present the program with academic and/or scholarly gains to inspire their participation (e.g. new startup ideas can also be new research ideas).

[c.] More details in the complete report [13]

B. Learner profile

The original proposal focused on training academic scientists working on SUD research. However, as a result of the needs assessment, the importance of a multidisciplinary team for startup creation was greatly highlighted, specifically for decreasing the perception of risk and adding diverse scholarship needed for the sustainability of the entrepreneurial endeavors. Identifying the optimum learner profile evolved into a call for action for all STEM professionals, SUD-researchers, engineers, computer scientists and technologists, experts in finance, management and entrepreneurship, to participate in the efforts needed to address the SUD challenge.

C. Learner selection and admission

An online application system was used to select only the top eligible candidates, those with the skills and drive to utilize their research and expertise for developing suitable SUD startups. The admissions process required the applicant's resumes, LinkedIn profile, and a short video interview answering a set of predefined questions. These questions are used to assess specific mindsets that are key for a successful entrepreneur: *a) Capacity for Calculated Risk*: Weighting risk and pivoting when necessary; *b) Open and Critical Thinking*: Collaboration and openness to new ideas; *c) Focus on Community*: Track record of contributing to their community; *d) Initiative with Follow-Through*: Actions reflecting intentions and persistence; and *e) Collaborative identity*: Self-aware rather than self-centered learners, those who put the team above themselves.

D. The program structure

We approach the SUD epidemic through the lens of the Grand Challenges for Engineers in the 21st century. The US National Academy of Engineering, with input from people around the world, identified this century's grand challenges for engineers and aligned them to broad cross-cutting themes: 1) *Sustainability*, 2) *Health*, 3) *Security* and 4) *Joy of living* [14]. We understand the severity of the SUD epidemic as a Grand Challenge in the *Health* theme given the impact it has on public health, though we acknowledge SUD affects other domains, especially the *Joy of living*.

Tackling the SUD challenge combining the engineering, entrepreneurship and innovation lenses, the program starts with asynchronous and synchronous online activities, followed by an in-person bootcamp, and concludes with an invitation to a community of peers so learners can continue their entrepreneurship efforts via a solid support network. The online activities included a) two self-paced asynchronous courses in entrepreneurship focused on experiential learning and case studies (Entrepreneurship 101 and 102) [15], b) one self-paced asynchronous module on the fundamentals of SUD (SUD 101) centered on context awareness regarding the SUD epidemic via learner self-reflection [16] and low stakes quizzes [17,18], and c) a series of synchronous webinars covering program basics and logistics, community building activities, and guests technical talks and Q&A sessions, scaffolded to promote interactions between peers, group discussion and peer learning [19]. After completion of the online activities, all learners were invited to MIT's campus for a 5-days in-person hands on, challenge-based, team-centric bootcamp that included analysis of case studies, followed by class discussion, and teamwork [20].

The whole learning journey took 2.5 months for completion, with overall time commitment of 89.5 hours: 36 hours for online asynchronous activities, 9 for live online events, and 44.5 hours for the in-person activities. Using results from the needs assessment, we aimed for a compact but intensive learning experience optimally suited to the learners' time restrictions. Fig. 1 presents in more details the different activities, their modality, and the approximate time required for completion, as well as when the research instruments were deployed.

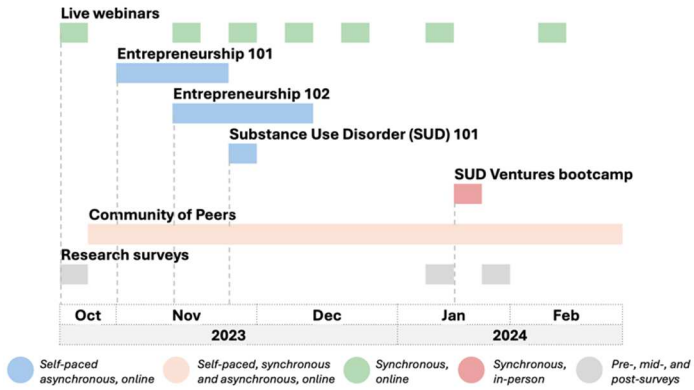

Fig. 1. Complete MIT Ventures learning journey. Different colors reflect learning modalities. Grey blocks signal research instruments.

1) Entrepreneurship 101: This asynchronous, self-paced course of 16 hours, focuses on the primary skills required for aspiring entrepreneurs, and is meant for learners with none or few entrepreneurship knowledge. Entrepreneurship is a creative process but following a methodical and disciplined approach is necessary for its long-term success. This course teaches how to combine creativity and discipline using scenario-based and problem-based learning, through case studies of startup companies and their founders. This approach allows learners to be exposed to innovations in different fields, and in the process, learn how to interview potential customers, understand the crucial difference between top-down and bottom-up market analysis, and develop a strategic framework for deciding what markets to pursue for a specific product or service.

2) Entrepreneurship 102: This self-paced, asynchronous course of 16 hours centers on the process of creating a product or service: entrepreneurial product design. It is meant for learners with basic entrepreneurship knowledge. Learners are encouraged to seek, strive, and iterate quickly through reliable insights while considering resource scarcity. The approach to product design is holistic: focusing to translate user needs into product priorities and product priorities into experience design. The learning journey is based on scenario-based learning through case studies and guided activities.

3) Substance Use Disorder (SUD) 101: This asynchronous, self-paced module comprises three sections that take approximately 4 hours to complete. It is offered to learners with none or few SUD knowledge. The three sections of the module are 1) prevalence and overview of SUD, 2) neurobiology of SUD, and 3) treatment of SUD. Each section includes facts and knowledge checks that learners submit online for the program team to understand the learners' initial SUD knowledge. This module also allows participants to post questions for an expert to cover them in one synchronous webinar focused on SUD.

4) Synchronous webinars: A total of eight synchronous online activities (1.5 hours each) were offered to learners to gauge engagement and participation in the asynchronous material, foster community building, and prepare them for the in-person activities. Some sessions also sought to clarify questions about program logistics and technical content (specially SUD for non-SUD learners). The sessions were:

- One onboarding session before the program starts.
- Two community building activities, one early in the program, during the online activities and another one close to the in-person bootcamp
- Four technical sessions with domain experts, one in technology licensing and commercialization in biomedical devices, a webinar on translating healthcare research into healthcare entrepreneurship, a session on strategic intellectual property (IP) for SUD ventures, and a SUD Q&A session.
- After the in-person activities, the team offered learners a debriefing, reflection and next steps session to strengthen the community bond and set clear short, mid- and long-term goals to continue the work in the field.

5) Entrepreneurship book: As a complement to the asynchronous entrepreneurship courses, all learners were given a digital copy of the "Disciplined Entrepreneurship" book [21], which is the basis for the Entrepreneurship 101 and 102 content, and covers in more detail the different steps required for structured startup creation.

6) In-person bootcamp: This 5-days intensive, 44.5 hours of hands-on, project-based, team-focused in-person academic and personal sprints aimed to immerse learners into real-life scenarios. It required applying all the new content knowledge and skills covered in the online courses in a team setting: all learners were arranged in teams with peers of multidisciplinary expertise. Fig. 2 depicts in detail the in-person bootcamp.

- *Coaches:* During the in-person bootcamp, participants learn to solve a specific SUD problem defined by themselves. Given the intensity of this experience, they require additionally guidance and facilitation by coaches. Each participating team is guided by seasoned coaches, alumni of the MIT Bootcamps programs, who are entrepreneurs, investors, or practicing biomedical entrepreneurs. They are instrumental for the education, research and industry crosspollination.
- *Themes:* The 5 different days of activities during the in-person bootcamp were organized in specific themes that provide a clear objective per day. These themes were: 1) Opportunity Identification, 2) Understanding Stakeholders, 3) Solution Discovery, 4) Venture creation, and 5) Pitch Presentation.
- *Program structure:* The learning journey was divided in 1) SUD-specific case studies, 2) lectures and workshops with experts (regarding intellectual property, funding, the US healthcare system and regulation), 3) peer panels, 4) team work (focused on developing a SUD-specific product or service based on an identified need, with daily deliverables, and a final pitch presentation), and 5) sessions with NIDA staff regarding regulation, federal and state training opportunities and startup funding options.

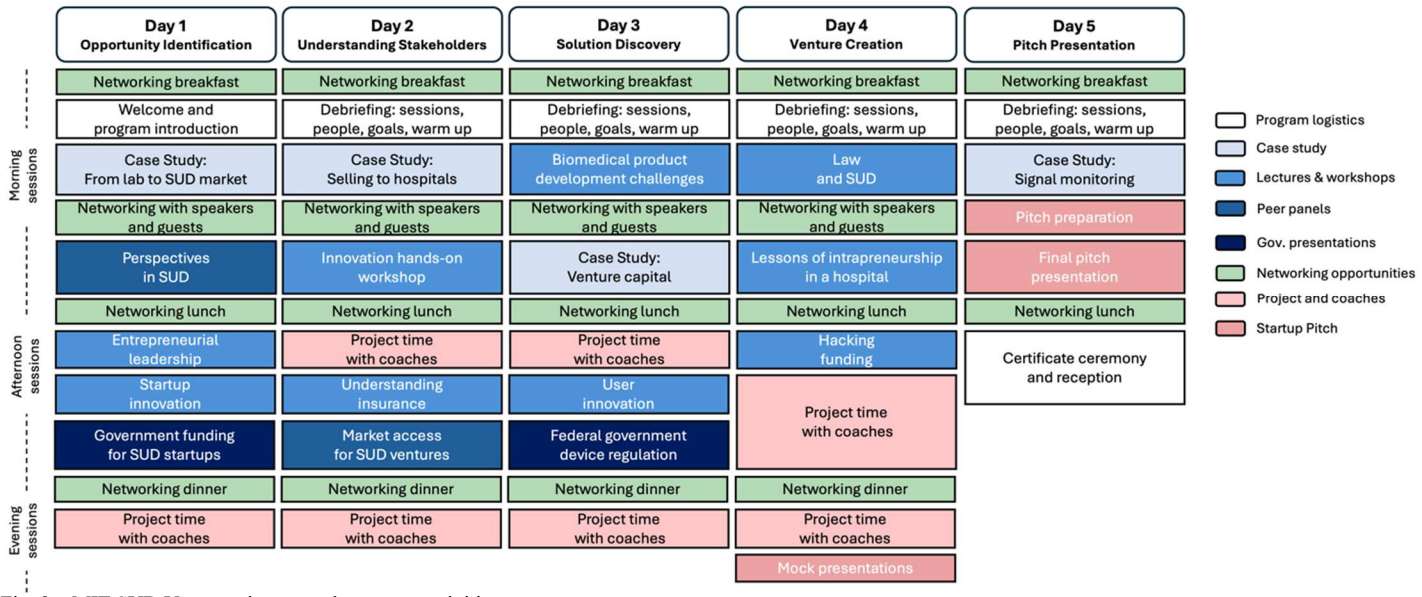

Fig. 2. MIT SUD Ventures in-person bootcamp activities

- *Readings and case preparation:* Before the in-person activities, learners were provided with case study readings and questions to promote self-reflection, group discussions, testing their knowledge, and connect the cases with their own SUD-specific startup ideas.

E. User innovation

An important component in our program is the introduction of the field of *user innovation*, which states that those suffering a problem are also responsible for a significant body of breakthrough product or service innovation relevant to its solution [22]. Those who have the need to solve their problem are very often those who tend to pioneer functionally novel products and services. In the context of SUD, user innovation is especially relevant given that it is fundamental to position those suffering from SUD in the center of the process, considering their needs and those of their support group, and empower them as agents of change while fighting societal SUD stigma. Approaches and processes aiming to reach a solution to the SUD challenge are worth further studying within the context of engineering problem identification and problem solving.

III. Research Component

The overarching research goal of the program is to understand the appropriate pedagogy, learning modalities, technological innovations, bespoke content, and support resources needed to guide and advance the design and implementation of academic programs seeking to support the translation of SUD research into products and services for the prevention, diagnosis, and treatment of SUD.

Our program innovation, in the context of engineering education, is MIT's approach to teaching entrepreneurship and innovation. We highlight the importance of a needs assessment study to understand the pedagogies, content and technology needs of tentative learners, as well as to develop and implement a curriculum that is appropriate for learners with diverse background, including STEM professionals, especially engineers, computer scientists and technologists. Moreover, our research results make a clear comparison between the perception, experience, and learning gains of engineers and STEM scientists vs. the overall learner pool, pointing out to specific considerations necessary when offering similar innovation and entrepreneurship programs to diverse learners.

A. Research population

All the learners accepted to the program were invited to participate in the academic research. The complete research protocol, research procedures and data collection were approved by the MIT IRB (COUHES). Informed consent was provided to all research subjects.

B. Research design and timeline

We use a mixed methods approach. Participation in the study involved completing three electronic surveys (a pre-, mid- and post-program survey) in year 1 and up to five follow up surveys (6 months, 1, 2, 3, and 4 years after completion, depending on which cohort they belong to, until the end of the program). The pre-survey seeks to gather baseline information before the program's kickoff regarding the learner's experience with entrepreneurship, SUD, and various pedagogical approaches and educational technology. It also queries the learners' program expectations, what they consider their field of expertise, their perception of the funding opportunities for SUD startups and their intentions for starting a SUD venture. The mid-survey is deployed after learners have completed the online training activities. It aims to evaluate their experience on each course, and additional program resources and events. The post-survey takes place at the end of the in-person bootcamp (and program completion). It aims to evaluate content, pedagogies, and educational technology, facilitating and challenging factors, as well as the learner's experience working in teams, and with the bootcamp coaches. It also assesses changes in the learner's perception about funding opportunities or their intentions to develop a SUD startup. The follow up surveys are deployed to understand if/how the program impacted the learner's prospects towards developing SUD solutions and the value and usage of NIH/NIDA funding opportunities for SUD startups.

IV. RESULTS

A. Cohort profile

As of May 2024, the first two years of the cooperation agreement between NIDA and MIT have taken place. The first year was dedicated to the needs assessment evaluation, the learner profile definition, and curriculum development; while the second year was focused on admissions for the first cohort of learners and delivery of the program to those accepted.

Cohort one included 34 learners, with 18 having an academic or research background (52.9%), and 16 working or having some level of knowledge in SUD (47.1%). The learner's average and mode age are 36.2 and 40 years, respectively (± 8.6 years), with ages ranging from 21 to 52 years. Learners had a mix of expertise, including engineering, tech or biomedical product development, health or SUD knowledge, entrepreneurship, and management or associated areas.

B. Curriculum delivery

The program was offered from October 2023 to January 2024. In total, learners were exposed to 3 asynchronous online courses, 8 live online sessions (webinars), and a 5-day in-person program comprised of 4 case study sessions, 10 innovation workshop sessions, 2 peer-learning activities, 2 talks delivered in cooperation with NIDA, as well as 17-hours of coach-guided team-based work. The hands-on, problem-based curriculum exposed participants to top MIT entrepreneurship instructors and faculty, 6 practicing biomedical entrepreneurs, and 2 intrapreneurs, with different levels of experience in NIH Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) funding opportunities. The in-person bootcamp gathered 2 MIT researchers (leading the program evaluation), 4 MIT instructors, 5 MIT bootcamp coaches, 9 guest speakers, 4 NIDA team members; and 12 experts from the MIT community.

C. Community of peers and networking activities

At program launch, guided by the needs assessment results, learners were grouped in small learning teams of 3-4 to maximize scholarship and expertise diversity (with at least one expert in STEM, engineering or health sciences, one expert in entrepreneurship, and one in SUD). Learners were encouraged to connect during the asynchronous experience to solve questions and discuss topics of interest. In the online webinars, 5 out of 8 sessions had a significant community-building component (average participation of 89% learners).

A learning platform provided all learners with the cohort's profile, including contact information, bios, and photos. Learners also created an informal social media group, via WhatsApp, where all communicated during the program. For the in-person activities, learners were distributed into larger teams (4 teams of 6 learners and 2 teams of 5) based on their interest in topics related to SUD prevention, detection, and solution spaces, to co-create with their team-mates a pitch for a product or service in the SUD field.

Other networking activities were designed into the curriculum (breakfast, lunch, and dinner) for building connections with peers, teaching staff, guests and coaches.

D. Research subjects profile

From the whole cohort, 31 learners (91.2%) provided consent to participate in the research either in the pre-, mid- or post-survey. From these, 15 identified as women (48.4%), 15 as men (48.4%), and 1 (3.2%) did not disclose their gender identity. The average and mode age of the research subjects is 36.1 and 40 years, respectively (± 9.1 years), with ages ranging from 21 to 52 years. The respondents' field of work, based on post-survey responses, was 53.6% academia (15), 46.4% private sector (13), 10.7% NGO (3), 3.6% government (1), and 2 preferred not to disclose it (7.1%). The learners' highest level of education, based on post-survey responses, was 14.3% College (4), 32.1% Master's (9), and 53.6% Doctoral degree (15). Table IV summarizes the respondents core field of expertise.

TABLE IV. SURVEY RESPONDENTS MAIN FIELD OF EXPERTISE

Field of expertise	Pre-survey responses	Mid-survey responses	Post-survey responses
Engineering, tech development and biomedical product development	11 (44%)	10 (38.5%)	10 (35.7%)
Healthcare or SUD	19 (76%)	21 (80.8%)	20 (71.4%)
Entrepreneurship, business, management	12 (48%)	14 (53.8%)	14 (50%)
Total number of responses (%)	25 (73.5%)	26 (76.5%)	28 (82.4%)

E. Content

- *Online entrepreneurship courses:* Most respondents covered the Entrepreneurship 101 and 102 courses (25, 96.2%). Those without entrepreneurship experience found a lot of value in the content.
- *Entrepreneurship book:* 38.5% (10) respondents read the whole book, 50% (13) skimmed through it, and 11.5% (3) did not read it at all. In general, learners highly praised the book and its role as foundational for the entrepreneurship courses.
- *SUD 101:* All respondents stated they went over the SUD 101 material (26, 100%), both respondents with and without SUD expertise. For non-SUD experts (14, 53.8%) this material was most valuable. Some respondents requested more details about biomedical products and behavioral approaches to treatment of SUD, as well as addressing SUD stigma.
- *In-person bootcamp:* All activities were positively evaluated, especially the *Entrepreneurial Leadership* session, the *Lessons from Intrapreneurship in a Hospital*, the NIDA-led lectures and the peer panels. Some re-tuning is necessary for the *Law and SUD* session, and the case studies (mainly providing readings with enough time for learners to prepare them). Respondents also requested to streamline the goals of each day, and some suggested moving some presentations to the online format so the face-to-face time could be used for more Q&A and conversation between the speakers and learners.

Respondents highlighted the participation of NIDA during the in-person activities, especially their talks and continuous feedback during the week. The value of government funding

insights, mainly the SBIR and STTR, was repeatedly mentioned in the post-survey responses.

F. *Perception of risks, readiness for creating a startup, and funding opportunities in the SUD field*

1) Change in risk perception about creating a SUD-related startup: When learners were asked, after program completion, to rate changes in their perception of risk regarding creating an SUD in the venture/startup space, there were mixed results. The perception of risk increased for more than half the respondents (53%), similarly results in all fields of expertise, including entrepreneurs. See Fig. 3 for details.

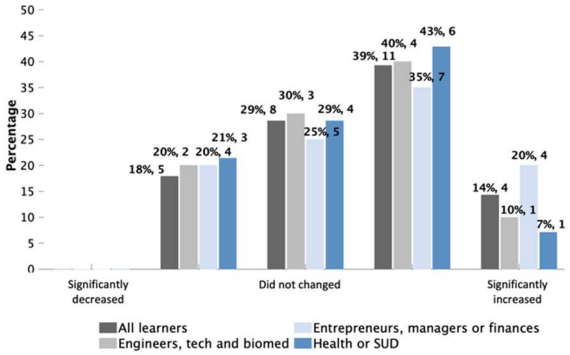

Fig. 3. Post-program change in risk perception about creating a SUD startup.

2) Readiness to create a SUD-focused startup: Most respondents (96%) expressed their perceived readiness (feeling 'somehow ready' or 'really ready') to create a SUD startup increased after completing the program (100% for engineers). There was an increase in 19% due to the in-person bootcamp (after the online activities this perception was 77% for all learners, and 80% for engineers,). A 4% of respondents, all of them learners with expertise in the health or SUD field, did not express any change in their perception of readiness (Fig. 4).

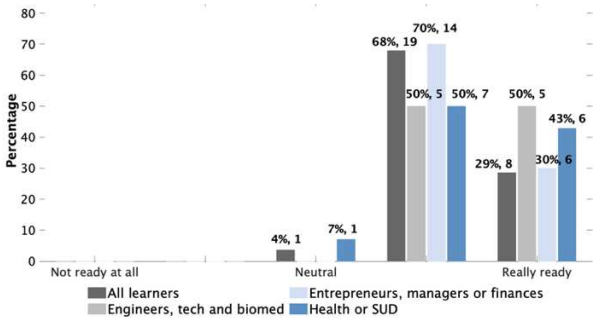

Fig. 4. Post-program change in perception of readiness to create a SUD startup by field of expertise.

3) SUD-related resources and funding opportunities: When asked if they have been funded by NIH or NIDA, 80% (20) responded negatively while 20% positively, mainly PIs on research projects.

In the pre-survey 96% (24) respondents expressed no knowledge about government resources to support SUD ventures. After completion, it seems learners were positively influenced regarding the perception of funding opportunities available for SUD-related startups: 89.3% (25) of the respondents expressed their perception positively changed while it stayed the same for 10.7% (3). No respondents reported negative changes in their perception of the available funding opportunities. When asked if learners planned to apply to any of these funding opportunities in the next 6 months, 53.6% (15) said yes (mostly to SBIR phase I, STTR, and BluePrint grants), while 46.4% (13) said not to be sure or no (most respondent mentioned other commitments, interest on developing the idea and other solutions further, and one respondent expressed concerns regarding the risk related to SUD startups).

4) Teamwork and cohort composition: When learners were asked if they felt they were placed in the right team, 85.7% (24) responded positively, mainly pointing out the diverse background and origin of team mates, offering a complimentary skillset to the team. Learners that responded negatively, 14.3% (4), expressed some different views regarding the solution they should focus on, hence affecting team dynamics. Overall, respondents highlighted the usefulness of the team work in their learning journey, the quality of their peers, and the value of the domain knowledge diversity (see Table V for details in these responses by field of expertise). Other issues in team dynamics and composition were expressed: one team mainly composed of learners with a clinical background felt the lack of diversity affected their performance and chances to win the pitch competition, and internal conflicts related to defining the solution explored led some respondents to express they would have preferred continuing with their own project idea.

TABLE V. TEAMWORK SUPPORT FOR LEARNING, COHORT QUALITY AND DOMAIN KNOWLEDGE DIVERSITY. AVERAGE (ST. DEV) SCALE 1-5

Field of expertise	Total resp.	Usefulness of team work for learning (1-5) [d]	Quality of fellow learners (1-5) [e]	Domain knowledge diversity (1-5) [e]
Aggregate (all) fields	28 (100%)	4.68 (0.61)	4.89 (0.31)	4.79 (0.50)
Engineering, tech and biomedical product development	10 (35.7%)	4.67 (0.64)	4.88 (0.34)	4.79 (0.51)
Healthcare or SUD	20 (71.4%)	4.67 (0.62)	4.89 (0.32)	4.78 (0.51)
Entrep., business, management	14 (50%)	4.68 (0.61)	4.89 (0.31)	4.79 (0.50)

d. 1 - Not useful at all, 5 - Extremely useful

e. 1 - Very poor, 5 - Very good

G. *Overall program satisfaction*

When post-survey respondents were asked to share their overall program experience (i.e. how the program changed their professional mindset and future professional plans), they praised the 'can do' mindset towards entrepreneurship provided by the program, the access to potential collaborations for seeking government funding and creating SUD-focused startups. This perception aligns with the answers to how likely respondents were to recommend the program: In a scale of 0 - 10 (0 – *"I would not recommend it at all"*, 10 – *"I would definitely recommend it"*) respondents rated it in average 9.61 (similar responses in all fields of expertise). Regarding the quality of the cohort, 100% rated peers as slightly good and very good (similar results when data explored by the respondents' fields of

expertise). When asked about the cohort's domain knowledge diversity, 96% learners expressed the diversity was slightly good or very good (similar results when data explored by respondents in different fields of expertise).

When asked what the whole program (complete online and in-person activities) helped respondents the most regarding how to create a startup/venture in the SUD space, the key perceived learning gains were:

1) Federal funding: Understanding the available federal funding opportunities, specially the SBIR and STTR, and demystifying that funding for SUD ventures is readily available (most learners had no knowledge of these based on pre-survey results). This is especially important for engineers, tech and biomedical product developers with non-SUD experience.

2) Disciplined entrepreneurship: Providing a systematic approach for entrepreneurship and venture creation, not only covered in the self-paced courses and the book but throughout the coaching and hands-on experience of the in-person activities. A structured roadmap is especially important to engineers: a systematic approach to measuring risk and uncertainty, evaluating ideas and possible solutions, customers and the market aligns with engineering practice.

3) Peer learning: Creating a community of peers, including the learners, coaches, mentors and program speakers to seek support even after program completion.

V. Discussion

A. Results highlights

Results suggest alumni perceive a higher level of risk in the SUD venture arena, yet also feel more ready to pursue startup creation in this domain. This could mean alumni might be more intentional in their startup approaches, avoiding common mistakes in the venture creation process: by knowing the risks they could be facing, they can be better prepared and increase their chances of success. Risk perception is also affected by the ever-changing regulation landscape regarding controlled substances, approved or banned treatment molecules, and overall the healthcare system: these considerations are important when considering federal vs. state regulations (which widely vary).

B. Program changes

The questionnaire results provide insights into how to better serve learners in future program iterations and were used to update the curriculum, the outreach and applicant selection guidelines: Content-wise, knowledge about the healthcare system and funding application process are topics the program will focus on in more detail in the future, as it is the role of stigma in SUD startup creation and funding. As a suggestion from learners and NIDA, more material on SUD will be offered to non-SUD researchers so their SUD knowledge baseline is increased. Moreover, different tracks of training prior to the in-person activities will be implement, for SUD researcher to omit the SUD material, and for seasoned entrepreneurs to avoid the basic entrepreneurship content. This can help optimizing the learner's experience and promote more time interacting with the community of peers.

Regarding pedagogy, talks covering basic knowledge about processes and regulation will be offered online rather than during the in-person activities. This would open more space for interactions between learners and speakers, including Q&A time, and digging deeper into their entrepreneurial efforts and startup journey. For the case studies and prep material offered, the program will provide more prep time for learners to be ready for the discussions during the in-person activities.

For the community of peers, the next cohort will be grouped not by their focus on prevention, diagnostics or treatment but rather on 1) supporting incarcerated communities, 2) prescription, 3) delivery and management of pharmaceuticals, 4) vulnerable populations, and 5) wild card (based on interests raised by participants). Moreover, live webinars and meetups will take place online throughout the whole year, seeking to better engage the community, and promote peer interaction.

C. Future steps

A fundamental program next step is to determine whether the different activities have equipped alumni with the necessary knowledge, skills and mindsets to apply for and secure startup funding for their SUD-focused ventures. To do so, the research team will continue with the follow up surveys (6 months, 1,2, 3- and 4-years post program completion) to understand the impact of the program on SUD startup creation and sustainability.

Regarding all material recorded and created for the first cohort, the program team will share it in open access platforms, including the MIT OpenCourseWare site (https://ocw.mit.edu).

VI. Conclusion

For the NIDA, the program's success stems from its role supporting the translation of sound, high-quality research into products and services for preventing, diagnosing, and treating SUD, and advancing a more diverse and vibrant SUD startup ecosystem. MIT's track record in the field of startup creation, forefront technology, biomedical research and product development positions the MIT Ventures program in a good place to train SUD researchers in entrepreneurship and biomedical innovation. The positive perceived outcomes of this program, reflected in the self-assessment of learning gains from learners, their perception of readiness to create a SUD-focused startup, their increased knowledge of startup funding opportunities, and their overall reception of the learning journey and their peers, are a first steps towards achieving NIDA's goal.

Our program presents encouraging results regarding training scientist and engineers in entrepreneurship to bridge the gap between academia and industry, specifically in the SUD context, by demystifying the concept of startup creation, offering a systematic approach, and presenting funding opportunities.

A. An innovative and structured entrepreneurship training approach for researchers and academics

The program's innovative approach to entrepreneurship and biomedical product development stems from its five methodological and pedagogical pillars. These pillars are:

1) Content framing under diverse scholarship: Combining entrepreneurship, innovation, SUD, and education scholarship for the development and implementation of the program.

2) Needs assessment: Using an evidence-based approach for curriculum development by understanding learner needs.

3) Coaches: Facilitating the learning experience through the support of diverse, seasoned coaches.

4) Community of peers: Fostering a diverse community of learning to ensure sustainability during and after program completion.

5) Diverse learning body: Innovation and problem-solving are maximized in teams that include participants with diverse backgrounds. The different life experiences, perspectives and context fosters crosspollination of ideas, leading to innovation.

This model can be implemented to train entrepreneurship to STEM-focused learners. Engineering education challenges encountered in the program, especially for STEM professionals practicing outside the healthcare and SUD environment, are the lack of knowledge learners have regarding government regulation, the complexities of the healthcare system, restrictions related to healthcare data handling, clinical trials, and the need to understand the end-user of the desired solution, as well as the importance of developing grant-writing craftsmanship to get funding for future SUD-focused ventures. All these factors could possibly hinder moving research ideas into SUD products or services. Having identified these knowledge-gaps, our educational model can be used to frame future programs for solutions beyond the SUD space.

B. Reframing SUD as a healthcare and societal challenge and calling engineers and STEM proffesionals for action

SUD is not a personal choice or lifestyle but the result of complex interactions between genetic and environmental factors. SUD and addiction lead to anatomical and physiological brain changes that impair anyone suffering from SUD from quitting. The misconception and stigma that those suffering SUD lack willpower to quit needs to be eradicated. Only doing so will open avenues for healing and better supporting the population suffering from this challenge. Furthermore, the SUD challenge requires highly synergistic multidisciplinary approaches. The program team wishes for all engineers and STEM professionals to understand the opportunities ahead to support the development of solutions to the SUD challenge and other Health Grand Challenges. Our program is part of three different SUD entrepreneurship programs supported by NIDA at different US universities, which are currently receiving applicants for the next three years to foster solutions to the SUD epidemic: everybody is welcome to apply.

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