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Analyzing the Impact of Two Co-Curricular Undergraduate Experiential Learning Programs on STEM Students' Career Readiness

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1. Career readiness, 21st century skills, and role models

The number of science, technology, engineering, and mathematics (STEM) graduates in the US has increased in recent years, leading to more competition for available STEM jobs [1]. US-based employers have reported that STEM alumni show deficits in employability-related, generic skills, also termed '21st century skills' [2].

Developing students' 21st century skills remains a challenge for many higher education institutions [3]. Accordingly, students' 21st century skill levels often do not correlate with levels of academic achievement [4]. It is therefore unsurprising that education researchers [3,5] and organizations [6,7], both general and STEM-focused, have called for substantial changes to curriculum, instruction, and assessment to increase alumni's career readiness.

Two major approaches for developing students' career readiness during their undergraduate studies are research experiences and work-integrated learning [1]. Both approaches are forms of experiential learning in which students get to apply their knowledge, reflect on their work, engage in abstract conceptualization, and experiment, thus covering all four bases of learning [8], and both approaches clearly align with the development of 21st century skills.

The Career Readiness Competencies as defined by the National Association of Colleges and Employers have been adopted by many US-based higher education institutes. However, this list was created based mostly (more than 80%) on input from high-level executives, the methodology by which it was created has not been published, and it is not focused on STEM [9]. A list was formulated of 21st century skills specific to STEM (and to STEM education) and the sources and methodology behind the creation of this list were published by [10]. Their list of skills is as follows:

1. Applying knowledge to problems
2. Collaboration
3. Complex problem-solving
4. Creativity
5. Critical thinking
6. Engineering design
7. Entrepreneurship
8. Experimenting and testing
9. Individual learning
10. Intercultural understanding
11. Question posing
12. Spoken communication
13. Systems thinking
14. Written communication

In their work, [10] analyzed survey data from nearly 1,600 alumni of a STEM-centric higher education institution outside of the US and derived a list of methods of teaching and learning (e.g., lecture or project), matching them to the development of each skill based on survey responses. They also matched each method of teaching and learning to forms of teaching and learning as formulated by [11] (e.g., receiving directions from an instructor or working with others). This effort allows the matching of a 21st century skill to method of teaching and learning and to forms of teaching and learning.

Role models are involved in an individual student's life, providing them with guidance, access to professional and social networks [12], and teaching them career-related skills [13]. Role models can help foster STEM students' self-efficacy by providing them with encouragement and promoting a sense of belonging [14,15] and have been shown to promote students' aspirations and achievements [16-18].

2. Experiential learning programs at MIT: NEET and UROP

The *New Engineering Education Transformation* (NEET) program began as a pilot in 2017 as part of a school-wide effort by the School of Engineering at the *Massachusetts Institute of Technology* (MIT) to innovate its undergraduate engineering education. A cross-departmental co-curricular initiative, NEET emphasizes interdisciplinary experiential learning to foster students' skills, knowledge, and attributes related to 21st-century challenges and careers. The program is opt-in, opt-out and three years long (sophomore through senior year). NEET students simultaneously earn a degree in their chosen major and a certificate in one of NEET's pathways of study, or 'threads', in the usual four years. As of October 2024, NEET had 227 enrolled students and 175 alumni.

NEET offers four threads in interdisciplinary domains: Autonomous Machines; Climate & Sustainability Systems; Digital Cities; and Living Machines. Each thread is led by a faculty member and a full-time lead instructor (MIT lecturers) who help develop students' ability to conceive, design, implement, and operate technological applications and/or conduct scientific research, all in collaboration with various possible combinations of other undergraduate students, graduate students, postdoctoral fellows, staff, faculty, or industry professionals. More information on NEET and its history can be found in previous publications [19-27].

In 1969, Margaret MacVicar, then a 26-year-old MIT professor (and alumna), established the *Undergraduate Research Opportunities Program* (UROP) at MIT with funding from the inventor Edwin Land. In this long-established research experience program undergraduate students conduct research for one or two semesters under a faculty member and in collaboration with various possible combinations of graduate students, postdoctoral fellows, research staff, faculty, or industry/medical professionals. This notably successful program has spread to universities around the world. 93% of MIT's undergraduate alumni have participated in one or more UROP experiences [28]. Due to its very high participation rate (almost every MIT alumnus has done at least one UROP), we chose to analyze this program together with the NEET program.

3. Research objective and research questions

The goal of this paper is to analyze the NEET program's contribution to career readiness as well as that of UROP, as reported by alumni of both programs and as pertaining to their time at MIT. Our research questions were as follows:

1. What is the importance of each 21st century skill to participants' career readiness?
2. What are the differences in the respective contributions of NEET and UROP to participants' 21st century skill development and how do they complement each other?
3. What kind of and how many role models did participants encounter in NEET and UROP?
4. Are there other factors such as the participants' college major, gender, race, or NEET thread that might also affect students' 21st century skill development?

We limited our study to the two founding threads of NEET: Autonomous Machines and Living Machines. We chose the founding threads because they have undergone fewer changes in curriculum in recent years compared to the two newer threads and they had the largest potential pools of program alumni, with five cohorts having completed NEET (and graduated from MIT) from 2020-2024.

4. Methods and materials

4.1. Data collection

This study received approval from MIT's institutional review board for human subject research, E-5414 (fall 2023 data collection, see [26]) and E-6258 (fall 2024 data collection).

To answer the study's research questions, we designed an online survey that included the following sections:

1. Informed consent to participate in the study (with the option to *agree* or *disagree*).
2. Demographic and academic details.

3. Experience at MIT, which covered items related to career readiness: 21st century skill development and finding role models.
4. Current career, which covered items related to career readiness, including a list of 21st century skills.

We used email and social media to reach NEET alumni, based on existing contact details we had on record. A total of 35 NEET alumni responded to the online survey: 18 from the Autonomous Machines thread (out of 91 total thread alumni) and 17 from the Living Machines thread (out of 48 total thread alumni). The response rate across both threads was 25% of the total number of alumni.

4.2. Data analysis

We provide descriptive statistics for the following, based on respondents' self-reporting on:

- The degree of development of each 21st century skill during their time at MIT, ranging from 1 (not at all) to 4 (very much).
- The importance of each 21st century skill for their current career, ranging from 1 (not important at all) to 4 (very important).
- Role models they encountered at MIT, whether in NEET or in another program/setting.
- Their level of career satisfaction, ranging from 1 (I very much *disagree* that I am satisfied with my current role) to 5 (I very much *agree* that I am satisfied with my current role).
- How well NEET helped prepare them for their current role, ranging from 1 (I very much *disagree* that NEET helped prepare me for my current role) to 5 (I very much *agree* that NEET helped prepare me for my current role).

We used nonparametric tests for inferential statistical testing, since the data we analyzed did not have a normal distribution for every 21st century skill, see Appendix.

We provide inferential statistics in the form of Mann-Whitney U tests to determine if there were significant differences in levels of 21st century skill development across respondents:

- NEET threads—Autonomous Machines; Living Machines.
- Genders—Woman; Man. One respondent chose not to identify their gender.

We provide inferential statistics in the form of Kruskal-Wallis H tests to determine if there were significant differences in levels of 21st century skill development across respondents:

- College majors—Mechanical Engineering; Electrical Engineering and Computer science (EECS); Biological Engineering. We excluded from analysis four responses which did not belong in either category and which were all different from each other. Additionally, one respondent chose not to identify their major.
- Races—Asian; White; Hispanic or Latino; Black or African-American. We excluded from analysis four responses which did not belong in either category and which were all different from each other. Additionally, two other respondents chose not to identify their race.

5. Findings

5.1 Demographic and academic details

Table 1 summarizes respondents' demographic details.

Table 1. Respondents' demographic details.

Category (N = 35)	Sub-category	N respondents		
		NEET Autonomous Machines thread	*NEET Living Machines thread*	*Total*
Gender	Woman	7	13	20
	Man	11	3	14
	Did not identify	0	1	1
Ethnicity	Asian	5	7	12
	White	8	4	12
	Hispanic or Latino	3	3	6
	Black or African-American	1	0	1
	White and Asian	0	1	1
	White and Latino	1	0	1
	Did not identify	1	2	3

Table 2 summarizes respondents' details as they pertain to their academic studies at MIT.

Table 2. Respondents' academic details.

Category	Sub-category	N respondents		
		NEET Autonomous Machines thread ($n_1 = 18$)	*NEET Living Machines thread* ($n_2 = 17$)	*Total*
Graduation year	2020	5	3	8
	2021	1	1	2
	2022	3	4	7
	2023	4	5	9
	2024	5	4	9
College major[1]	Mechanical Eng.	12	3	15
	Elec. Eng. & Comp. Sci.	5	5	10
	Biological Engineering	0	8	8
	Biology	0	3	3
	Aerospace Engineering	1	0	1
	Art and Design	0	1	1
	Management	0	1	1

[1] Four respondents have obtained two college majors each.

5.2. Career readiness

5.2.1. Development of 21st century skills at MIT, including in NEET.

Table 3 summarizes respondents' self-reported degree of skill development at MIT. Every skill had a median of either 3 (moderately) or 4 (very much).

Table 3. Respondents' self-reported 21st century skill development at MIT.

21st century skill N = 35	Score 1: "Not at all"; 2: "Hardly"; 3: "Moderately"; 4: "Very much"		
	Minimum	*Maximum*	*Median*
Applying knowledge to problems	3	4	4
Complex problem-solving	2	4	4
Collaboration	2	4	4
Creativity	2	4	3
Critical thinking	2	4	4
Experimenting and testing	2	4	4
Engineering design	2	4	3
Entrepreneurship	2	4	3
Formulating questions	2	4	3
Intercultural understanding	2	4	3
Learning by oneself	2	4	4
Spoken communication	2	4	3
Systems thinking	2	4	4
Written communication	2	4	3

Table 4 compares the number of responses referring to 21st century skill development in NEET to the number of responses referring to UROP (N = 35). The number of responses referring to both NEET and 21st century skills ranged from 9-27.

NEET and UROP complement each other, with the former having a higher number of responses for collaboration, creativity, engineering design, entrepreneurship, spoken communication, systems thinking and written communication, and the latter having a higher response for experimenting and testing, critical thinking, formulating questions and learning by oneself. The number of responses was about the same for applying knowledge to problems, complex problem-solving and intercultural understanding.

Table 4. Contributions of NEET and UROP to respondents' 21st century skill development.

21st century skill N = 35	Number of responses		χ^2 [1]	p-value
	NEET	*UROP*		
Applying knowledge to problems	26	27	0.019	0.891
Complex problem-solving	24	25	0.020	0.886
Collaboration	**27**	**13**	**4.900**	**< 0.05**
Creativity	21	19	0.100	0.752
Critical thinking	17	21	0.421	0.516
Experimenting and testing	**11**	**24**	**4.829**	**< 0.05**
Engineering design	24	16	1.600	0.206
Entrepreneurship	**9**	**2**	**4.455**	**< 0.05**
Formulating questions	15	25	2.500	0.114
Intercultural understanding	9	8	0.059	0.808
Learning by oneself	15	19	0.471	0.493
Spoken communication	**23**	**10**	**5.121**	**< 0.05**
Systems thinking	23	13	2.778	0.096
Written communication	18	14	0.500	0.480

[1] Degrees of freedom are 1 for every skill.

When dividing the potential range of responses for NEET for each skill (0-35 responses) into three groups of an equal range (0-11; 12-23; 24-35 responses), we find that the bottom third contains three skills (entrepreneurship; experimenting and testing; intercultural understanding),

the middle third contains seven skills, and the top third contains four skills (applying knowledge to problems; collaboration; complex problem-solving; engineering design).

Table 5 compares respondents' self-reported levels of 21st century skill development by NEET thread (N = 35). Autonomous Machines differed from Living Machines for creativity, engineering design, and systems thinking, with the former having the higher median scores for all three skills.

Table 5. Respondents' self-reported 21st century skill development at MIT, by NEET thread.

21st century skill N = 35	Median score 1: "Not at all"; 2: "Hardly"; 3: "Moderately"; 4: "Very much"		U[1]	p-value
	NEET Autonomous Machines thread (n_1 = 18)	*NEET Living Machines thread* (n_2 = 17)		
Applying knowledge to problems	4	3	106.0	0.064
Complex problem-solving	4	4	112.5	0.091
Collaboration	4	4	144.5	0.746
Creativity	**4**	**3**	**83.0**	**< 0.05**
Critical thinking	4	4	122.0	0.206
Experimenting and testing	4	4	157.0	0.881
Engineering design	**4**	**3**	**71.0**	**< 0.05**
Entrepreneurship	3	2	148.0	0.861
Formulating questions	3	3	153.0	1.000
Intercultural understanding	3	3	179.0	0.361
Learning by oneself	4	4	149.0	0.881
Spoken communication	3	3	151.5	0.958
Systems thinking	**4**	**3**	**79.0**	**< 0.05**
Written communication	3	3	170.0	0.480

[1] Degrees of freedom are 1 for every skill.

Table 6 compares respondents' self-reported levels of 21st century skill development by college major at MIT (N = 33). Majors with only one or two responses were not included in this comparison. There were no significant differences for any of the skills.

Table 6. Respondents' self-reported 21st century skill development at MIT, by college major.

21st century skill N = 33	Median score 1: "Not at all"; 2: "Hardly"; 3: "Moderately"; 4: "Very much"			H[1]	p-value
	Mechanical Eng. (n_1 = 15)	*Elec. Eng. & Computer Sci.* (n_2 = 10)	*Biological Engineering* (n_3 = 8)		
Applying knowledge to problems	4	3	3.5	5.734	0.057
Complex problem-solving	4	3.5	4	4.380	0.112
Collaboration	4	4	3.5	0.239	0.887
Creativity	4	3	3	4.631	0.099
Critical thinking	4	4	3.5	3.225	0.199
Experimenting and testing	3.5	3.5	4	0.806	0.668
Engineering design	4	3	3	2.961	0.227
Entrepreneurship	3	2.5	2.5	1.284	0.526
Formulating questions	3.5	3	3	0.166	0.920
Intercultural understanding	3	3.5	4	3.778	0.151
Learning by oneself	4	4	3.5	0.239	0.887
Spoken communication	3	3.5	4	0.824	0.662
Systems thinking	4	3.5	3.5	1.469	0.480
Written communication	3	3	3	1.321	0.517

[1] Degrees of freedom are 2 for every skill.

Table 7 compares respondents' self-reported levels of 21st century skill development by gender (N = 34). One respondent did not identify their gender. There were no significant differences for any of the skills.

Table 7. Respondents' self-reported 21st century skill development at MIT, by gender.

21st century skill N = 34	Median score 1: "Not at all"; 2: "Hardly"; 3: "Moderately"; 4: "Very much"		U[1]	p-value
	Woman (n_1 = 20)	*Man* (n_2 = 14)		
Applying knowledge to problems	3.5	4	180.0	.096
Complex problem-solving	4	4	178.0	.095
Collaboration	3	4	171.5	.205
Creativity	**3**	**4**	**205.0**	**< 0.05**
Critical thinking	4	4	177.0	.103
Experimenting and testing	4	3.5	132.0	.752
Engineering design	**3**	**4**	**204.0**	**< 0.05**
Entrepreneurship	2	3	182.0	.119
Formulating questions	3	4	173.0	.208
Intercultural understanding	3	3	138.0	.940
Learning by oneself	3	4	172.0	.205
Spoken communication	3	3	143.0	.911
Systems thinking	**3**	**4**	**207.5**	**< 0.05**
Written communication	3	3	118.0	.320

[1] Degrees of freedom are 1 for every skill.

Table 8 compares respondents' self-reported levels of 21st century skill development by race (N = 30). Race designations with only one response were not included in this comparison. There were no significant differences be for any of the skills.

Table 8. Respondents' self-reported 21st century skill development at MIT, by race.

21st century skill N = 30	Median score 1: "Not at all"; 2: "Hardly"; 3: "Moderately"; 4: "Very much"			H^1	p-value
	Asian ($n_1 = 12$)	*White* ($n_2 = 12$)	*Hispanic or Latino* ($n_3 = 6$)		
Applying knowledge to problems	3	4	4	3.167	0.205
Complex problem-solving	4	4	4	4.110	0.128
Collaboration	4	3.5	4	0.447	0.800
Creativity	3	4	3.5	2.007	0.367
Critical thinking	4	4	4	4.110	0.128
Experimenting and testing	4	4	3.5	0.326	0.850
Engineering design	3	4	4	3.710	0.156
Entrepreneurship	2	3	3	4.882	0.087
Formulating questions	3	3.5	4	2.66	0.264
Intercultural understanding	4	3	3.5	0.263	0.877
Learning by oneself	4	3	4	5.109	0.078
Spoken communication	4	3	3	0.174	0.916
Systems thinking	3	4	4	4.537	0.103
Written communication	3	3	3	0.625	0.731

[1] Degrees of freedom are 2 for every skill.

5.2.2. Importance of each 21st century skill to career success for respondents

Table 9 summarizes respondents' self-assigned importance of each 21st century skill to their career success. Every skill has a median of either 3 (important) or 4 (very important), except for entrepreneurship, with a median of 2 (hardly important).

Table 9. Importance of 21st century skill to career success.

21st century skill N = 35	Median score 1: "Not important at all"; 2: "Hardly important"; 3: "Important"; 4: "Very important"		
	Minimum	*Maximum*	*Median*
Applying knowledge to problems	2	4	4
Complex problem-solving	2	4	4
Collaboration	2	4	4
Creativity	2	4	4
Critical thinking	2	4	4
Experimenting and testing	2	4	4
Engineering design	2	4	3
Entrepreneurship	2	4	2
Formulating questions	2	4	4
Intercultural understanding	2	4	3
Learning by oneself	2	4	4
Spoken communication	2	4	4
Systems thinking	2	4	4
Written communication	2	4	4

5.2.3. Overall contribution of NEET to career readiness

In response to the item "My experience in [NEET] helped prepare me for my career in ways that my other experiences at [MIT] did not", five respondents marked '5', 17 respondents marked '4', 10 marked '3', two marked '2', and no one marked '1'. One respondent left this item blank. The scale of responses used for this item was 1 = 'I very much *disagree*' to 5 = 'I very much *agree*'. In summary, 32 of the 35 respondents reported that NEET provided them with some added value in relation to their career readiness.

Example quotes from respondents who marked '5' for this item:

#11 [Man, White, Electrical Engineering & Computer Science Major, NEET Autonomous Machines thread]: “Getting the opportunity to work on real-world projects in a collaborative cohort setting was a defining part of my NEET experience. This experience much more closely mimics what I'll be doing after I graduate.”

#18 [Woman, White, Mechanical Engineering major, NEET Autonomous Machines thread]: “NEET helped me learn to work in a team which has been a very important skill while working. Also being able to communicate your work and ideas is very important and another skill NEET helped me with.”

#25 [Woman, Asian, Biological Engineering major, NEET Living Machines thread]: “My NEET experience was very complementary to the other classes/UROPs I took (which were more basic science research) — am very grateful to have had the opportunity to explore engineering at a school known for engineering! The community was also very friendly and supportive, and I met a lot of great people through NEET”.

5.2.4. Role models encountered at MIT

Respondents were asked “Did you find any role models at [NEET]? If so, please describe the most influential one or two role models and their career-related impact on you. If you did not find any role models in [NEET] but did find role models at [MIT] outside of [NEET], then please describe them instead.”

Table 10 summarizes the number of mentions of role models in respondents’ responses as they reported having encountered at MIT. 31 respondents out of the 35 respondents mentioned encountering at least one role model at MIT, and 40 role models were mentioned in total.

Table 10. Role models encountered at MIT.

Role model category	N responses for encountering role model/s at MIT			
	NEET	*UROP*	*Another setting*	*Total*
Faculty	5	2	6	13
Instructor (staff)	3	1	2	6
Undergraduate student	4	0	5	9
Graduate student/postdoc	2	4	3	9
MIT alumni	1	0	1	2
Other	0	0	1[1]	1
Total	15	7	18	40

[1] One respondent mentioned engineering YouTube creators.

Examples quotes from respondents who mentioned encountering models in NEET:

#1 [Woman, Asian, Electrical Engineering & Computer Science major, NEET Autonomous Machines thread]: "I appreciated the patience, kindness, and efforts of the technical [thread] instructors in NEET and tried to emulate these characteristics when I TA'ed classes later on (specifically, I developed better spoken and written communication skills and collaboration skills)."

#4 [Man, White, Mechanical Engineering major, NEET Autonomous Machines thread]: "I definitely found a strong role model in my experience at NEET. They motivated me to truly grow in my time in MIT and pushed me to go further than I could have on my own. They were also always there for career advice outside of MIT, whether it be advice for internships, jobs, or even graduate school. I'm thankful to have had someone so impactful and invested in my growth at MIT."

#28 [Woman, White, Biological Engineering major, NEET Living Machines thread]: "Yes, my instructor in NEET became a key mentor to me during my time in undergrad and beyond; I relied on them for academic and professional support and guidance and continue to maintain a relationship with them post-graduation. They were my biggest cheerleaders as well as providing me opportunities for leadership within the program that strengthened my communication and collaborative skills. In addition, I learned various engineering design, problem solving, and critical thinking skills under their instruction."

5.2.5. Overall satisfaction with current role

In response to the item “I am satisfied at my current role.”:

- 12 respondents marked ‘5’
- 13 respondents marked ‘4’
- 9 respondents marked ‘3’

The scale used was 1 = ‘I very much *disagree*’ to 5 = ‘I very much *agree*’.

6. Discussion

6.1. 21st century skill development

NEET was reported to enhance certain skills more effectively than UROP, and UROP enhanced certain skills more effectively than NEET. This suggests that different experiential learning formats may be suited to developing different skill sets, and that they could complement each other. This aligns with literature suggesting the need for diverse educational approaches to fully equip students for a range of professional challenges [6,7].

We found differences between women and men (Table 7), and between the two threads of NEET (Table 5), for the same three skills and only for these skills: creativity, engineering design, and systems thinking. A potential explanation for these similarities could be the dominance of women in the Living Machines thread (13 women and 3 men), as undergraduate STEM men students have been reported have higher self-efficacy than their women counterparts [29,30]. However, this phenomenon alone does not explain why these three specific skills are different. It might be a result of the Autonomous Machines curriculum, gender composition, or other factors.

The overall positive responses regarding career readiness (Table 9) and satisfaction among respondents of NEET suggest that such experiential learning initiatives can play a significant role in enhancing students' perceptions of their preparedness for professional roles and for tackling societal challenges. This is particularly relevant given the finding that students’ levels of

21st century skills do not always correlate with academic achievement [6], underscoring the importance of practical, hands-on experiences in education.

The four skills which were in the top third of potential number of responses (Table 4) were applying knowledge to problems, collaboration, complex problem-solving, and engineering design. Based on [10]'s mapping of 21st century skills to methods of teaching and learning, these skills can be best developed through lectures, course assignments, and projects. This list of methods aligns well with the existing curricula in both NEET threads.

The three skills which were in the bottom third of potential number of responses (Table 4) were entrepreneurship, experimenting and testing, and intercultural understanding. Based on [10]'s mapping of 21st century skills to methods of teaching and learning, these skills can be best developed through research and projects. While this list of methods also aligns well with the existing curricula in both NEET threads, perhaps the content of the project and research experiences in both threads does not include sufficient elements to help students develop those three skills. Indeed, NEET was not formed as an entrepreneurship program, and as Table 9 shows, entrepreneurship was the only skill that received a score lower than 3 (by respondents) for the parameter on importance to their career.

NEET does not include studies and experiential learning abroad; however, MIT and NEET have some international students participating, and there may be an opportunity to incorporate intercultural understanding into the curricula of both threads. NEET's Climate & Sustainability Systems thread already formally includes this aspect, and it may be possible to adapt some of the work done in this thread to the Autonomous Machines and Living Machines threads.

6.2. Role models

The findings related to role models within NEET and the broader university environment echo the theoretical insights which discuss the impact of role models on STEM students: providing students with a sense of belonging and self-efficacy [12,13], encouraging and facilitating their professional aspirations [14-18], and helping to develop their higher-order thinking skills [15]. In

NEET, faculty, instructors, and students spend three years (six semesters) together, which provides role model opportunities not available to students elsewhere.

6.3. Research limitations and future studies

A larger sample of respondents would allow us to conduct analyses similar to those we carried out in this study, but within each NEET thread rather than across them. These analyses would provide greater accuracy since we have discovered several differences between threads in the self-reported development of some of the 21st century skills. Additionally, a larger sample may be closer to a normal distribution of scores which will allow us to conduct multivariate analyses and uncover interaction effects between different factors such as college major, gender, and race.

Another potential approach would be to add a sample of MIT alumni who were not in NEET but were in UROP. Pairing NEET alumni with participants in this new group based on college major, gender, and race would help clarify NEET's unique contribution to students' 21st century skill development.

The survey method, while allowing for collecting both quantitative and qualitative data, poses limitations for deep data collection. Interviews and focus groups would allow us to better understand the richness of students' experiences in NEET.

Lastly, the alumni's point of view is not the only relevant one when it comes to NEET's contribution to its alumni's career readiness. Asking the alumni's employers about their employees' career readiness could help provide another external perspective without self-bias.

We could conduct an intervention study in which we implement a new unit of curriculum for intercultural understanding in both founding threads of NEET. This unit would be developed based on the knowledge created in the Climate & Sustainability Systems thread and on the mapping of 21st century skills to methods of teaching and learning [10], and forms of teaching and learning [11].

6.4. Research Contributions and Suggestions for Future Studies

By providing empirical data on how participation in an experiential learning program like NEET influences the development of 21st-century skills, the study adds quantitative evidence to the discourse on the effectiveness of such programs in STEM undergraduate education.

The study's analysis of NEET and UROP offers insights into how different experiential learning models contribute uniquely to skill development. This comparative approach helps to delineate the specific contributions of project-based learning and of research-based learning.

The research underlines the alignment of educational programs with the evolving needs of the STEM industry. By documenting specific skills that are enhanced through participation in NEET, the study supports ongoing discussions about how universities can adapt their curricula to better prepare students for the demands of modern societal challenges and STEM careers.

Finally, the study also contributes methodologically by using a combination of survey items to provide different perspectives on the development of students' 21st century skills. This provides a template for other educational researchers looking to assess program impacts in a similar context.

7. Conclusion

A recent white paper [7] described the 'engineer of the future' as someone possessing a combination of disciplinary specialization and cross-disciplinary competencies. It has been described eloquently as, "Whether it's tackling climate change, developing sustainable infrastructure, or sending humans to space, the future of engineering lies in the hands of those who can seamlessly bridge the gap between disciplines and work together to find creative solutions to our world's most pressing problems." [31]. This vision requires a flexible balance between fundamental, generalist, and specialized elements in the curriculum and the students' learning experience. With NEET, UROP, and other experiential learning programs, MIT aims to help move its undergraduate engineering education offering towards such a balance.

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Appendix: Normality Tests

Table A. Shapiro-Wilk normality tests for each 21st century skill.

21st century skill N = 29	W[1]	p-value
Applying knowledge to problems	.613	< 0.05
Complex problem-solving	.613	< 0.05
Collaboration	.692	< 0.05
Creativity	.779	< 0.05
Critical thinking	.631	< 0.05
Experimenting and testing	.723	< 0.05
Engineering design	.761	< 0.05
Entrepreneurship	.856	< 0.05
Formulating questions	.783	< 0.05
Intercultural understanding	.817	< 0.05
Learning by oneself	.723	< 0.05
Spoken communication	.785	< 0.05
Systems thinking	.738	< 0.05
Written communication	.718	< 0.05

[1] Degrees of freedom are 35 for every skill.