

Designing for Student Well-Being

by

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Abstract

High levels of student stress are prevalent at MIT, especially among the undergraduate community. Many undergraduate students report that the MIT environment is harmful to their mental health. However, the current research efforts at MIT are mainly quantitative and do not capture the deeper insights required to understand the underlying stress factors and students' needs. This thesis aims to contribute to the knowledge about undergraduate student well-being at MIT through in-depth qualitative research. It also seeks to explore a well-being intervention informed by the research findings. This thesis is composed of two studies: a series of interviews and a design case study. Sixteen one-on-one interviews with MIT undergraduate students were conducted to gather in-depth qualitative insights. Internal, social, and academic pressures to manage a high workload were identified as the main stress factors. Findings indicate that students want to remain productive while maintaining peace and cheerfulness in their MIT experiences. Students' related needs are also discussed. The case study explored using an SMS bot to practice self-reflection, increase self-awareness, and prioritize well-being. Thirty-four MIT students participated in the study to use the bot every morning and night for two weeks. The changes in participants' self-awareness, mental well-being, and perceived stress levels were measured through pre-, mid-, and post-study surveys and compared to a control condition with an alternative intervention (open-ended journaling through texting). The results are discussed. Participants shared their appreciation of the bot's friendly and caring tone, simplicity of use, and content.

Thesis Supervisor: Matthew S. Kressy

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Chapter 1

Introduction

The mental health of university students has been an increasing concern. According to the American College Health Association's Spring 2019 report, 45% of college students have reported that they "felt so depressed that it was difficult to function" within the last 12 months. Moreover, 87.4% have reported that they have "felt overwhelmed by all [they] had to do," 65.7% have "felt overwhelming anxiety," 65.5% have "felt very lonely," and 55.9% have "felt things were hopeless" within the same period [1]. The pandemic due to COVID-19 has only exacerbated the difficulties with mental health; specifically, it has increased stress and anxiety for college students [2].

The data indicate the existence of vast opportunities for improvement in the MIT community. The HealthyMinds Survey shows that 77% of the MIT undergraduate students feel that the academic environment harms their mental and emotional well-being, more than double the national average of 36% [3]. Perhaps because MIT is one of the best universities in the world, many MIT students liken their experience at MIT to "drinking from a firehose" due to the overwhelming number of opportunities and the challenging academics [4]. Yet academic success and rigor may be taking a toll on student mental health. MIT students think "stress" is the most negative aspect of the MIT environment for them [5]. The data show that undergraduate students experience this stress even more than the graduate students, scoring -1.7 on a scale of -3 ("stressful") to 3 ("calm") while graduate students average -1.3, still significantly on the negative side [5]. Although there have been studies at MIT to identify stress factors for students, these are mainly quantitative studies and do not capture the more profound insights required to understand the underlying causes of stress and students' needs for greater well-being.

The purpose of this research is to examine the factors contributing to stress for the undergraduate students and the opportunities for greater well-being for them at MIT through in-depth qualitative

research. The study also aims to develop and test a well-being intervention informed by the research findings to respond to the increased student needs in this area. In particular, it explores the idea of an artificial intelligence bot to support students in their journeys to authentic well-being.

Chapter 2

Research Process and Findings

2.1 Research Goals

The goal of this research is twofold:

- 1) Understand the factors that contribute to MIT undergraduate students' stress levels.
- 2) Identify opportunities to improve MIT undergraduate students' well-being.

This research is used to develop solutions to the key issues and increase well-being for undergraduate students at MIT. This research will also contribute to knowledge about undergraduate student well-being at MIT. Student teams and organizations that aim to promote or increase well-being at MIT can use the research results to understand undergraduate students' needs better and make informed decisions.

2.2 Research Participants

Sixteen undergraduate students participated in this research. Participants were selected from diverse majors, years of study, genders, and ethnic and national backgrounds to capture rich and diverse insights that represent MIT's overall population. While sixteen participants is a relatively low number, the answers to the interview questions became consistent by the sixteenth interview, decreasing the value of additional interviews with the time constraints. This phenomenon is further explained below. **Figure 1** shows the participants' school year, major, gender, nationality, and ethnicity distribution.

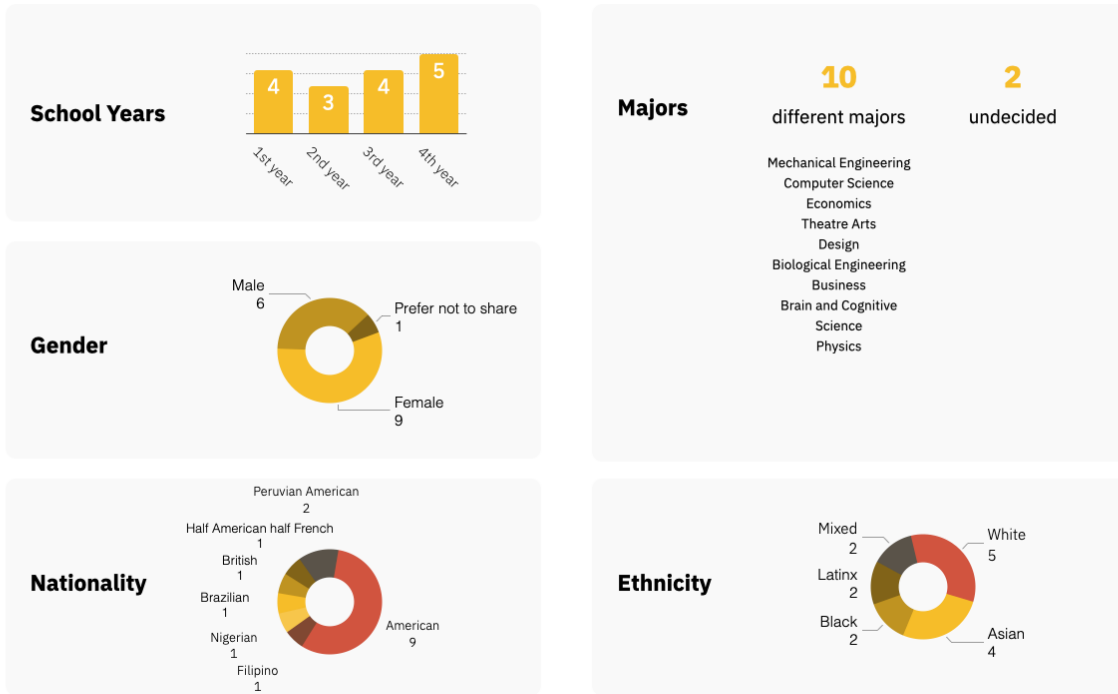


Figure 1. Research participants' school year, major, gender, nationality, and ethnicity distribution.

Participant recruitment was done by reaching out to the researcher's undergraduate student connections, asking them to refer their friends to the study, and sending a mass recruitment email to MIT's undergraduate dorm email lists. The first two strategies were effective in starting the conversations and in testing and polishing the interview guide. However, these two strategies did not help with recruiting participants from diverse backgrounds and perspectives, as most of the connections and their networks were white American students. Sending mass recruitment emails to undergraduate dorms that encouraged people from different years of study, majors, ethnicities, and nationalities to participate in the research helped to vary the research participants' profiles (see **Appendix A** for the recruitment email).

As a general guideline for interviews, 10 to 50 one-on-one interactions are recommended to capture the majority of the participant needs [6]. Therefore, each new insight after the 10th interview was examined to evaluate newness or redundancy. After the 16th interview, the data nearly reached saturation, and the value of conducting additional interviews diminished. With consideration of this and the time limit, the interviews were completed after the 16th interview.

2.3 Methods

2.3.1 Interviews

All the identified MIT studies on well-being were quantitative; therefore, all the available data were quantitative data. Quantitative data are invaluable for determining the size and scale of a problem and for comparisons of various items. In fact, the quantitative research data from the 2020 MIT Student Life Survey illustrated that stress is a severe problem at MIT, especially for undergraduate students. It also showed that undergraduate students scored the MIT environment as being harmful to their mental well-being (an average of -0.8 on a scale of -3 to 3), whereas they found it neither harmful nor beneficial to their physical well-being (an average of 0 on a scale of -3.0 to 3.0). These pieces of information were crucial for identifying an impactful investigation and intervention area for this study. However, quantitative research is inadequate for capturing the deeper insights required in this research.

This research aims to understand the "why" behind the analyzed quantitative data and identify opportunities for well-being interventions: Why are students feeling stressed? Why do they find these factors stressful in the first place? What do they find helpful, and what do they find not helpful while feeling stressed? What do they need? To capture these insights, the researcher should probe broadly and loosely structure the sessions to enable flexibility [7]. That is why qualitative research was the preferred research method. Specifically, one-on-one, hour-long, in-depth interviews were used due to the research participants' privacy and confidentiality needs for discussing well-being topics comfortably.

The interview questions included question categories about participants' (i) pre-MIT experiences to understand their expectations and how well their expectations were met; (ii) MIT experiences including their mood at MIT and stress factors; (iii) goals and how well MIT is helping meet these goals; and (iv) ideas for MIT to improve student well-being. *Twenty Moods* cards designed by Pieter Desmet, Haian Xue, and Steven Fokkinga from the Delft University of Technology were used while asking participants about their current and ideal moods at MIT [8]. **Figure 2** shows an overview of the twenty mood states. These images evoke thoughts and emotions in participants that are often difficult to reach through traditional

verbal question-and-answer techniques. This prevents the conversations from staying on the surface level and helps them become more profound. See **Appendix B** for the full interview questions.

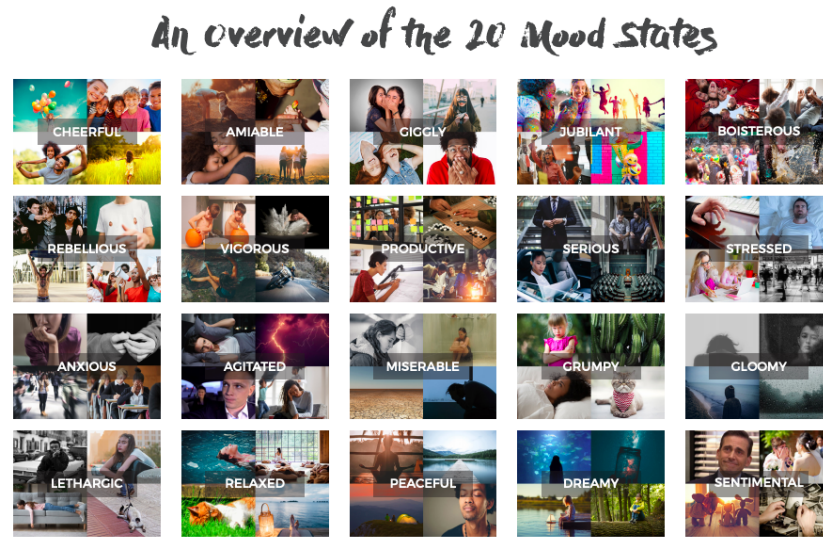


Figure 2. An overview of the *Twenty Moods* cards designed by Pieter Desmet, Haian Xue, and Steven Fokkinga.

2.3.2 Qualitative Data Analysis

The interviews happened on Zoom and were recorded with Zoom’s video-recording feature after receiving participants’ consent. During the interviews, the participants’ statements and emotions were noted impartially in preparation for analysis. After the interviews, the conversations were transcribed and combined with the interview notes. The insightful quotes and observations were extracted from the interview transcripts and notes and “scrubbed.” [7] The quotes and observations reflecting similar needs were grouped together [6]. From these groups, need statements were created. Nielsen Norman Group’s three-part structure *[A user] needs [need] in order to accomplish [goal]* was used to write the need statements [9]. Finally, the needs were grouped in terms of an affinity to develop higher-level needs for simplicity in communicating them with stakeholders.

2.3.3 Design Opportunity Development and Selection

After the data analysis, several design opportunities were listed for each high-level need category for further design exploration. To support the ideation process, “how might we” questions were used. Each need statement could probe many “how might we” questions and design directions. However, in this research, one broad question for each key-need theme was asked to encourage initial, big and wild ideas. A combination of two opportunity areas was selected to proceed to the development and testing phases that are detailed in the section 3 (i.e “Case Study”).

2.4 Research Findings

Before coming to MIT, all of the participants expected to have a challenging experience here due to the tough academics. Although they were slightly hesitant about their ability to handle this workload, they felt proud for the opportunity to be part of this rigorous environment and they accepted this challenge.

Their expectation to have an academically challenging experience was validated when they started their studies at MIT. When asked about their *current* mood at MIT, all participants selected “Productive” and “Stressed.” When asked about their *ideal* mood at MIT, the majority of the participants again chose “Productive” along with “Peaceful” and “Cheerful.” Students’ stress factors and their desire to continue being productive while developing peacefulness and increasing cheerfulness in their lives are elaborated on in this section.

Four key-need themes emerged from the interviews. The undergraduate students at MIT need to (A) pursue their authentic success journeys, (B) have peace of mind while doing this, (C) be socially connected, and (D) be supported by MIT when they need it. **Figure 3** shows the four need themes along with the accompanying needs statements.

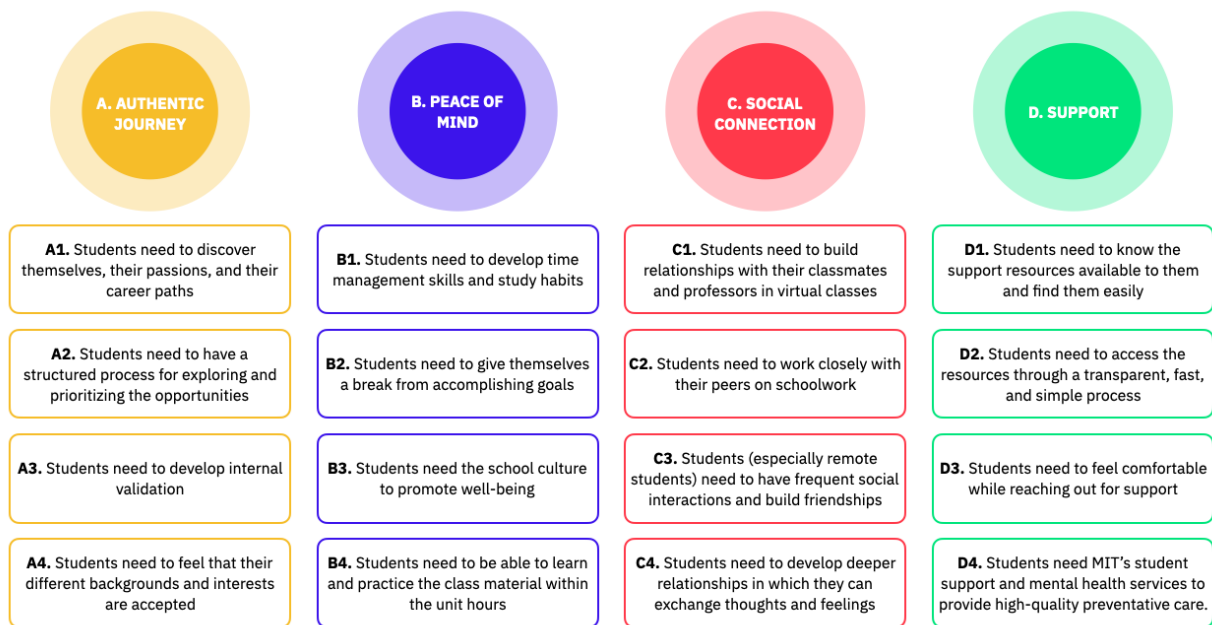


Figure 3. Need themes and related need statements (shortened).

A. Authentic Journeys

A1. Students need to discover themselves, their passions, and their career paths to be purposefully productive at MIT and beyond.

“I’d like to be productive. Productive not just in the fact that I’m doing work all day but productive in a direction that I understand.” - An interview participant

Being productive at MIT is very important for the students, but many of them lack an end goal. Almost all of the participants mentioned that they were always working on accomplishing tasks regarding their classes and extracurricular activities. A few of them even said they did not know how they were feeling at that moment because they had not had the time to think about this. Their principal reason for taking on a high workload is the desire to make the most out of their experiences at MIT. Not only did they work very hard to be here, but for most of them, their families also made enormous sacrifices for

them to be here. Now, they are in their dream school. Aware of all the “cool” opportunities they have at MIT, their biggest fear is not leveraging all of them and having regrets after they graduate.

If someone runs in a direction but does not know how they feel about it, can they know if they are going in the right direction? The rush to do a lot and being busy all the time prevented more than half of the study participants from looking into themselves to understand what they really wanted to accomplish in their lives. Working a lot without having an end goal in mind has created anxiety about the future for them. These participants wish to find their career paths and to be intentionally productive at MIT.

“I didn’t know what I was doing with my life, I didn’t like my classes. ...I think now I’m giving myself a chance to dream and being with people that helped me feel fulfilled in those dreams.” - An interview participant

One participant shared a relevant and wildly inspirational story. The pressure to fit in while she had no idea what she was doing with her life defined most of her MIT experience until her junior year. Although she was studying engineering, she did not like her engineering classes. Her heart was beating for art. However, since she had internalized that she needed to get a “technical job” after graduation, she ignored her desires and continued to strive to become a competent engineer. She did not know any other possibility for herself.

Starting her junior year, she began to talk to some of her engineering professors and shared her interest in the arts. She asked them how she could mix mechanical engineering with art. Her professors encouraged her to explore design. She started taking design classes and loved them. Then, she completed a design internship over the summer and became confident that she wanted to do a design-related job. Now, she is involved in design-related classes and is reaching out to people to learn more about opportunities in this field. She wished that she had given herself the chance to dream and had taken her dreams seriously enough to take steps to fulfill them earlier on.

A2. Students need to have a structured process for exploring and prioritizing the opportunities they can be involved in at MIT so that they can have more time to work toward their goals.

“The freshman year is for exploration, but nobody really explores.” - An interview participant

Although exploration is a crucial element of discovering a purpose, some students feel pressured to skip it to start progressing in their majors quickly. Some participants mentioned that they came to MIT without an explicit academic path in their minds and wanted to explore different paths at MIT. However, while exploring different majors was an option for first-year students, they did not explore as much as they would have liked. They were lost in too many available options. They did not feel guided during this process. Moreover, they observed that most students had already come with an idea of what they wanted to do and wanted to get out of MIT. These students, early in their freshman years, started working toward their goals and preparing for internships or research opportunities. Some participants admitted that they stuck to a major that they slightly liked because of their fear of falling behind and missing out. They wished they had been more cognizant and had a “game plan” to explore more smartly early in their freshman years.

“I overcommit myself to things because there are so many cool things that are going on. So, I end up having more things than I have time for.” - An interview participant

Some students, on the other hand, try to explore more than they have time for. The participants frequently mentioned that MIT had many “cool” opportunities that students could be involved in, including classes, student clubs, research roles, abroad opportunities, etc. They want to take advantage of them all. However, in this process, they sign up for more than they can manage. First-year students want to explore different extracurricular activities and communities to understand which is a fit for them. To grow themselves, upper-level students want to have leadership roles in student clubs and other opportunities related to their fields. The participants shared that having many things happen at the same time was extremely stressful and overwhelming for them. They also realize that the more they do, the less they do successfully. They wished they knew how to choose the right opportunities.

A3. Students need to develop internal validation to progress in their authentic journeys at their own pace against social pressure.

“We would be happier and healthier if we could leave just one thing altogether.” - An interview participant

Another reason students maintain a high workload and stress themselves in the process is social pressure. Some participants said they felt there was a constant expectation of doing a lot because everyone was doing a lot. Even if students want to drop some of their responsibilities, they are afraid that they will do less than everybody else, and others will think they are not capable enough to handle the load. In reality, some of the participants mentioned that nobody was managing well. Students think that they need to be super busy all the time, and if they are not, there is a problem with them. They stated the need for a cultural shift.

One participant said that there is an expectation to know everything and do the right things all the time at MIT. She argued that this prevented students from asking questions in class because they feared they would not look smart enough.

A4. Students need to feel that their different backgrounds and interests are accepted to have a sense of belonging at MIT.

“They say, ‘You are taking classes that aren’t about machine learning or technical things? Are you even a real MIT student?’” - An interview participant

A participant stated that there was a notion of a “real MIT student,” which is a student who studies engineering, is interested in high technology and machine learning, and works on cool research projects or internships. These students have a background in coding, even before coming to MIT. The participants shared that most of the clubs, research opportunities, and even introductory classes require a coding background. Suppose the student does not fit this description (i.e., studies humanities, does not have the background and/or interest in coding). In this case, the student experiences self-doubt and feels isolated.

B. Peace of Mind

B1. Students need to develop time management skills and study habits to be peacefully productive.

“If I could just manage my time well and direct my time and effort to the right things, then I would be able to achieve both productivity and peace.” - An interview participant

Almost all participants mentioned the high-level stress they were feeling due to academics at MIT. Although the classes are difficult, most of them think that this is not the main problem. Their struggle is mainly due to their poor time management. They think they need to develop better study habits—study regularly instead of working too much on any given day—and better time management skills so that they can be peacefully productive. A few participants expressed their wish to exercise more. Reflecting on why they had not exercised, they realized that they could exercise if they intentionally planned their free time.

B2. Students need to give themselves a break from accomplishing goals to prioritize their well-being and savor life.

“I was working constantly and did not know when I should take a break. I requested a week off for surgery. It was the most peaceful week I had. It was the only time I did not constantly have to do one thing after another.” - An interview participant

Most participants said they were constantly action-oriented, including during their weekends. They feel if they stop, they are doomed. They constantly rush and strive to check items off their to-do lists. This causes adverse effects, such as the following:

1. Missing chances for spending time with their friends and building and strengthening relationships;
2. Not giving themselves a mental break to destress and recharge;
3. Not slowing down to celebrate their accomplishments and savor their day-to-day lives;
4. Deprioritizing their well-being, they may skip meals and exercise and/or delay their sleep.

Many participants mentioned that they feel most peaceful and cheerful when they do things without an explicit goal, just for fun. They wished they could have more of this while at MIT.

B3. Students need the school culture to promote well-being to learn about prioritizing their well-being

“I think the main issue with prioritizing yourself at MIT is the expectations around having an all-nighter, sleeping two or three hours, being better or more hardworking, so that you are a ‘real MIT student.’” - An interview participant

A participant shared that being hardworking to the point that students compromise their sleep was the norm at MIT. She thinks that this norm discourages people from prioritizing their well-being. This is highly related to the social pressure discussed in need statement A3.

B4. Students need to be able to learn and practice the class material within the unit hours to maintain a work-life balance.

“Some professors think ‘We should make it really challenging because we're MIT.’” - An interview participant

Another reason why students have difficulty maintaining a work-life balance is intense academic pressure. Some classes are very difficult and require too much of the students' time, way more than their unit hours. Some participants mentioned that exams and quizzes are the biggest reason for their high stress levels because, for some of their classes, the exams and quizzes have an enormous weight on their grades. Therefore, failing one exam or quiz may result in a bad course grade. They also mentioned that the last weeks of classes are the most stressful period because exams, final assignments, projects, and lectures were happening at the same time. A few participants said some professors made their classes so challenging that the exam/quiz averages were very low (around 30-40 out of 100). These participants think this is not the students' problem but rather the professors' problem, because these professors

challenge students for the sake of challenging them, not to help students learn. Actually, their strategy prevents students from learning, as illustrated in the exam/quiz averages. Students acknowledge that the school wants to preserve the quality of education; however, they wish it does this in a way that does not stress them.

MIT actively communicates with students about the importance of well-being, but if students are socially or academically punished when they prioritize their well-being, how can the school expect them to sustain it?

C. Social Connection

C1. Students need to build relationships with their classmates and professors in virtual classes so that they can be engaged and have a sense of connection.

“I feel like there is no communication, no sense of connection. Blank screens and names. You are alone.”

- An interview participant

This year, due to Covid-19, students have had a very different college experience than in the past. The conversations with the first-year students attending the virtual classes outside of the US proved that their experience had been affected the most. They shared that they had been feeling unengaged in their large lecture-style classes, in which there were over a hundred students, mostly with their video in Zoom turned off. There was no personal touch and no interaction with professors or classmates. In these classes, the students were not able to develop a sense of connection. One study participant even said that the lack of interactions with professors impacted her experience so negatively that she felt like she was taking an online degree from a no-name university, not MIT. To be more intellectually stimulated, they wish to have one-on-one interactions with and mentorship from professors.

The first-year remote students liked the small classes in which they could get to know everyone in the class and regularly do discussions and group work. They wished all the classes were “friendly” and encouraged people to interact with each other.

C2. Students need to work closely with their peers on schoolwork to be academically supported.

“In my junior year, my engineering classes got really, really hard, but I also felt like I found more community because a lot of the work was group-based.” - An interview participant

“Classes got a lot harder with the pandemic. In the past, students would naturally meet during office hours and work together, whereas now you’re on your own.” - An interview participant

Students find collaborating with their peers on assignments motivating because they can support each other, solve problems together, and sometimes struggle together instead of struggling alone. Working with others provides students with both academic and emotional support. These collaborations are formed mostly spontaneously during office hours or after classes. However, online classes have made it difficult for students to form spontaneous support groups. It was especially hard for the first-year students to feel close enough to their classmates to ask them questions about their assignments.

C3. Students (especially remote students) need to have frequent social interactions and build friendships to have cheerful experiences at MIT.

“I’ve been really trying hard to make new friends. This is extremely hard now. But I think friends would make me more cheerful.” - An interview participant

Almost all the first- and second-year students expressed difficulty with making friends, given that most (if not all) of their MIT journeys had been online. This negatively affects their experiences because being with friends is what makes them happy and cheerful. They mentioned that they miss having people around them and spontaneous, in-person interactions. They wish MIT could create more opportunities for people to interact and build friendships.

C4. Students need to develop deeper relationships in which they can exchange thoughts and feelings to be emotionally supported.

“I was not able to share with anyone what I was going through. ...Then I met this friend ...and we would like to come to my room and talk about what she was going through and then I would tell her what I was going through. ...Just these little moments of listening to each other would help a lot.” - An interview participant

Having friends is a crucial first step for feeling emotionally supported, but it is not enough. A participant revealed that she had been feeling alone while being with other people. Students need to have close friends with whom they can be vulnerable and share what is really transpiring in their lives. Some participants described sharing their feelings and problems with other people as a life-changing experience for them. They believe that talking about their struggles and emotions with others is a way to reach solutions.

D. Support

D1. Students need to know the support resources available to them and find them easily so that they can ask for help when they need it.

“We get 10 therapy sessions included with our tuition. It's something that wasn't really ever advertised. That would have been a life-changer for me in my first year.” - An interview participant

Three research participants had conducted separate research projects on undergraduate students' well-being. Two of them maintained that resources are the biggest opportunity area at MIT. There are many resources at MIT to support students mentally and academically, and the students who are using these resources benefit a lot from them. However, unfortunately, many students are not aware of them and do not know when they can reach out for help.

This situation was apparent in the interviews. One participant mentioned that he had surgery, which resulted in having a lot of piled-up homework. He did not even consider reaching out for support. He dealt with the unrealistic load and stress alone. He also mentioned that there had been times when he had wanted to talk with someone about his struggle with the workload and time management, as well as balancing school and his other responsibilities. However, he did not know who to turn to. Another participant shared that he had learned the resources such as ten free therapy sessions, tutoring for the introduction classes as students adapt to the MIT workload, and the dean-on-call service in his final year. He wished he had known about these earlier, as they had been very beneficial—even a life changer—for him during his first two years.

D2. Students need to access the resources through a transparent, fast, and simple process to ask for and receive support when they need it.

“We are operating a lot of the time at our maximum bandwidth. And taking care of yourself is the easiest thing to push off. That’s why even though these barriers, like calling someone, might not seem like a big deal, they become a big deal.” - An interview participant

Three participants who had conducted separate mental well-being studies at MIT claimed that one of the barriers to using MIT’s resources was their non-transparent, complex processes. First, the resources are not centralized; therefore, students find looking for them overwhelming. Second, all processes, including the process of calling the MIT Medical and setting an appointment to access resources, feel operose for students. MIT students often operate at their maximum bandwidth. Confronting emotions and taking care of themselves have become the easiest things to push off. This is why calling someone, even though this might not seem like a big barrier, becomes one for them.

In urgent moments, when a student has a mental breakdown, appointment scheduling does not work. One participant mentioned that MIT Medical expects students to make appointments and stick to these, even in dire situations, and does not support students. These three participants wished MIT would make accessing therapy easier.

D3. Students need to feel comfortable while reaching out for support for them to do so.

“I think there is still -although it has decreased- a pretty significant amount of stigma surrounding reaching out and asking for help because everyone wants to be self-sufficient, and independent.” - An interview participant

Almost half of the study participants talked about the discomfort of reaching out for support. It was already discussed above that MIT has a culture of working a lot and being proud of handling a high workload. Students want to be sufficient and independent. This culture makes reaching out and asking for help unfavorable. This stigma, although it has decreased, is still prevalent at MIT.

The reason for not reaching out for help could also be the students' backgrounds. One participant shared that he had not used support resources during his first two years, even though he had struggled in his classes and felt alone. This was because of the biases that came from his negative past experiences. In the city where he is from, people laughed at him when he sought resources. When he finally felt confident enough to go to Student Support Services in his junior year, he felt very supported and quickly built relationships with people there. This was a massive positive change for him in his academic journey, and he regrets that he had not used this resource earlier. These conversations reveal that more campaigns to normalize asking and receiving help are needed.

Another barrier to feeling comfortable reaching out for help is not knowing whether the situation is serious or urgent enough for intervention. The resource centers might also have been encouraging this questioning. One participant claimed that Student Support Services only supported people who used specific words that indicated that the need is significant. Students feel judged and do not deserve support.

D4. Students need MIT's student support and mental health services to provide high-quality preventative care.

“People think MIT Medical gives short-term responses to problems. It should be preventative.” - An interview participant

Three participants provided secondhand information regarding concerns about the quality of MIT's mental health and support services. These concerns included students not having continuous relationships with the same therapist, the individual differences between support professionals (not having been supported while talking with some of the support professionals), and not having preventative mental health care.

2.5 Summary and Design Opportunities

This section summarizes the research outputs and identifies the opportunities to design well-being interventions.

2.5.1 Summary

The 16 one-hour interviews and analysis of the transcripts yielded insights into the stress factors and needs of MIT undergraduate students. Students' primary stress factors are (i) the pressure they place on themselves to make the most of their MIT experience, (ii) social pressure to work hard and to be constantly busy, and (iii) academic pressure coming from challenging classes and a high workload.

Because of these three types of pressures, they always have many things on their plates, and they struggle to keep up with everything and balance work and life. Since the school culture favors highly accomplished individuals who can handle much work simultaneously, students do not share their struggles and do not reach out for help. This causes students to feel alone in their struggles.

The research uncovered four key need themes. Students need to:

- Pursue their authentic success journeys
- Have peace of mind
- Be socially connected
- Be aware of and able to access high-quality support resources when they need them

2.5.2 Design Opportunities

Each need statement could probe many different “how might we” [10] questions and design directions. In this research, one broad question for each key need theme was asked to initiate the ideation phase. “We” in this instance refers specifically to MIT but could apply to any organization that aims to increase MIT student well-being.

- How might we help students pursue their authentic success journeys?
- How might we help students have peace of mind?
- How might we help students be socially connected?
- How might we reduce the barriers to asking for support?

2.5.2.1 Guided Journal

How might we help students pursue their authentic success journeys?

Dr. Bill Damon, the Director of the Stanford Adolescence Center, and his team found that young adults are stressed not just because they have too much to do but *because they do not know why they are doing it* [11]. Dr. Damon’s findings support this current research’s findings.

Research-backed, purpose-development organizations such as Project Wayfinder [12] and Purpose Project [13] claim that purpose development starts with discovering one’s authenticity. This discovery includes, but is not limited to, people understanding who they are, what they do and do not enjoy, what strengths they possess, and their passions and values. Tying these to purpose requires experimentation as much as reflection [12, 13]. People need to reflect on how they can incorporate these passions into their lives and live life according to their values and purpose. Finally, they need to take action to make these plans become real. These actions may include learning more about the interest area through research, developing relevant skills, creating a network of people in this area or who are knowledgeable in this area, and looking for opportunities for involvement. In summary, to develop purpose and pursue an authentic success journey, one must dream, take one’s dreams seriously, and start taking steps toward one’s dreams.

Being purpose-driven helps people intentionally choose and prioritize their tasks, motivates them, and gives them the strength to deal with difficulties. Research has proven that adults who experience purpose report higher psychological well-being [14], flourishing [15], hope [16], resilience [17], and work-life satisfaction [16].

An idea to aid students in pursuing their authentic journeys is to include a guided journal in their welcome packages. This journal may include probes to reflect on oneself, life, interests, passions, values, and purpose. It may ask questions such as: *What is important to you? What would a perfect day look like? What values are presented in this choice?* [18]. The journal may reveal ways to explore different interests and experiment with a purpose. It can guide them in identifying related classes, organizations, and communities to explore and people to talk with. This solution would not only help students reflect on their “why;” it would also help them navigate MIT more intentionally. This guided journal can be created by MIT using scientific research on purpose and meaning. Alternatively, MIT can partner with an outside research organization or purpose-learning organization, such as Project Wayfinder, Purpose Project, and nXu.

Another relevant (but more futuristic) idea is to use AI technology for this guided journal. A scenario with the AI guided-journal: AI named Alive reminds the user to reflect every day to find orientation and direction. The user may choose to talk with Alive to reflect or do journaling using Alive’s reflection prompts. Alive guides people to look into themselves and reflect on their lives, passions, values, and life purposes. Alive understands the users’ answers and customizes their responses and follow-up questions accordingly. It also suggests small experiments to help users test their interests and what works and does not work for them. Through an interface, users can access the recordings of their answers (text and audio) and relevant suggestions whenever they like.

Both solutions have comparative advantages and disadvantages. The first idea, the paper-guided-journal, is much more feasible, whereas the second one, AI-guided-journal, requires a high development cost. The feasibility and viability constraints for the second idea can be alleviated by designing a minimum viable product as the first step. The AI solution provides convenience compared to reflecting by using pen and paper, while the traditional guided journal provides a familiarity advantage—no setup or onboarding needed. Both solutions are more private than talking with a person and cheaper than a therapist. These ideas address the need statements A1 and partially address A2 and A3.

2.5.2.2 Well-Being Schedule

How might we help students have peace of mind?

This research shows that students need to develop time management skills, give themselves a break, and feel validated to prioritize their well-being to have a more peaceful experience at MIT. These needs provide an opportunity for a well-being schedule. Below is a description of this idea.

MIT creates the recommended well-being schedule by reviewing the well-being literature and studying the weekly schedules of the healthiest, happiest, and most successful MIT students. This schedule includes the recommended times allocated for classes, studying, eating, exercising, socializing, relaxing, sleeping, and more. Students can edit the schedule and customize it to their class schedules and preferences. The plan includes information about the rationale for the recommended activities and durations. It can also guide students to resources if they have difficulty with any aspect of the plan. Another critical aspect of this idea is that if many students are having difficulty completing coursework for a class in the allocated duration (i.e., the stated unit hours from the MIT Course Catalog), MIT will request that the course professor make amendments.

The well-being schedule idea will help students balance work, rest, and play while feeling on track. Students will also receive support to adhere to the schedule. Finally, it will help MIT track the actual time students spend on coursework and intervene when necessary to prevent overworking. This idea addresses the need statements B1, B2, B3 and B4.

2.5.2.3 Interactive Classes, Collaboration, and Friend-Matching

How might we help students be socially connected?

MIT undergraduate students need to have more interactions during lectures to feel engaged, work closely with their peers to be academically supported, and develop deep friendships to be cheerful and emotionally supported. This research proved that the strength of one's social support system is negatively

correlated with depression. Friends can give reappraisals that people cannot give themselves at the moment of crises, and reappraisals help lower the incidence of depression, better interpersonal functioning, higher levels of well-being, and reduce post-traumatic stress disorder symptom severity [19].

In this topic, three high-level ideas were created to address different needs related to social connections at MIT. First, professors can increase interaction and engagement in their classes by including group discussions and more opportunities for students to share their thoughts during the class. For large classes, one-on-one interactions with professors may be difficult. For this, professors can create these interactions during office hours. This idea addresses the need statement C1.

Second, in each class, professors can assign peers to work together on some assignments, especially the most difficult or time-consuming ones, so that students can work closely with each other, feel academically supported, and build new friendships. This idea addresses the need statement C2.

Lastly, finding and feeling a part of a friend group is crucial for student happiness and well-being at MIT, as this thesis research shows. Sometimes, these connections may not be easily created spontaneously, as they did not occur during the remote year due to COVID-19 pandemic. Even when education returns to being in person in the next academic year, some students may have difficulty finding their communities. This problem creates an opportunity for a friend-matching system. Below is the use-case scenario for this system.

Students add personal information to the friend-matching system including their major, year of study, interests, and hobbies. Then, they see two different matching-friend types: group and individual. They select the person and/or group of people by reviewing others' information. They view mutual availability and suggest a time to connect. Even better, they can select a shared interest (such as walking along the Charles River) and suggest this. After the meeting, students can give feedback on the system for future improvements.

This friend-matching idea can help students connect with other students who have similar interests and hobbies but who are not necessarily in similar majors or years of study. Therefore, this supports students in having a broader network at MIT. This idea addresses the need statements C3 and C4.

2.5.2.4 Need and Resource Matching

How might we reduce the barriers to asking for support?

This thesis research indicated that some MIT undergraduate students do not seek help because they do not know what resources exist. They also find the process they need to follow to connect to resources inconvenient.

A potential solution to these problems is positioning a chatbot on MIT's Student Life website. This chatbot can ask students what kind(s) of support they need and provide options to choose from, including "Other." After a student selects an option, the chatbot directs them to the relevant resource(s). If a student selects the option "Other," the chatbot connects them to a live agent. This agent listens to the students and shows them the resource that fits their needs the best. Both the chatbot and the live agent can direct students to the appointment system if the resource requires this. That way, students can set their appointments themselves without the need to call MIT Medical. For authenticity, Kerberos can be used.

This idea provides students with easy access to resources; therefore, it addresses the need statements D1 and D2.

2.5.3 Case Study

More study participants shared needs related to the need themes *Authentic Journey* and *Peace of Mind* than the other categories. Participants also expressed more intense emotions while talking about these categories.

From these two need categories, the participants highlighted the following two needs the most:

- Students need to discover themselves, their passions, and their career paths to be purposefully productive at MIT and beyond.
- Students need to give themselves a break from accomplishing their goals to prioritize their well-being and savor life.

Therefore, the *Guided Journal* and *Well-being Schedule* ideas were selected to be explored further. The following study aimed to create and test a minimum viable product (MVP) from a combination of

these ideas, considering time and resource constraints. The MVP is defined as an SMS bot that prompts self-reflection to increase self-awareness and provides daily suggestions to increase well-being.

Chapter 3

Case Study: Reflex

3.1 Introduction

In the United States, 51.5 million adults (20.6%) have mental illness(es). The incidence of mental illness in young adults is even higher, at 29.4% [20]. While many people are in need of mental health care and support, 28.5 million (55.2%) of US adults with mental illness did not receive inpatient, outpatient, or prescription medicine support within the past year - potentially due to financial, social, or personal barriers [20]. Specifically, the top barriers for seeking help for college students are preferring to deal with issues independently, questioning how serious their needs are, not having enough time, and normalizing stress in college [3].

The barriers to seeking therapy and medication and the ubiquitous Internet access created opportunities for digital mental health interventions. There is currently a blossoming space of mental health support apps and digital services. Some of these services, such as online therapies, are mediated by the health system and some of them, such as personal health trackers, are mediated by consumers and communities. Some of the consumer services are untested and unproven whereas others undergo formal clinical trials to prove their efficacy. These digital interventions range from mobile phone apps to online peer-to-peer support communities. Some interventions are targeted at certain mental health conditions using specific techniques, such as applying cognitive behavioral therapy to treat depression [21], while others reach a broader population who want to improve their well-being. As mental well-being has emerged more into public consciousness, many digital services and platforms aim to inspire and guide healthy behaviors such as physical activity (Nike+, Fitbit, etc.), mindfulness (Headspace, Calm, etc.), and

self-reflection (The Five Minute App, Day One, etc.). Digital tools to inspire self-reflection often take the form of journaling and mood tracking prompts in an app.

This study hypothesizes that receiving self-reflection probes and scientifically proven well-being suggestions every day from a friendly bot can increase self-awareness and mental well-being while decreasing stress levels for college students.

While most consumer digital mental health services are provided through mobile apps, setting up these apps remains one of the most significant barriers for usage [22]. There is an opportunity to explore a medium that does not require a setup for users. The study hypothesizes that the medium of SMS can be leveraged to provide an easier access to well-being interventions, specifically increased self-reflection.

To test the hypotheses, a textbot named Reflex, (combining the words reflect and text), which asks the types of questions a caring friend would ask, was developed. **Figure 4** shows Reflex and an exchange with a user. The aim was to prompt self-reflection through thoughtful questions and sentiment-informed responses so that the user feels heard and understood. The method was to quantify changes in self-awareness outcomes, well-being, perceived stress in the users of the chatbot. Collaborators on this study included the author; Kate Pearce, an undergraduate student majoring in Computer Science; and Katie Hahm, a graduate student in the Mechanical Engineering Department.

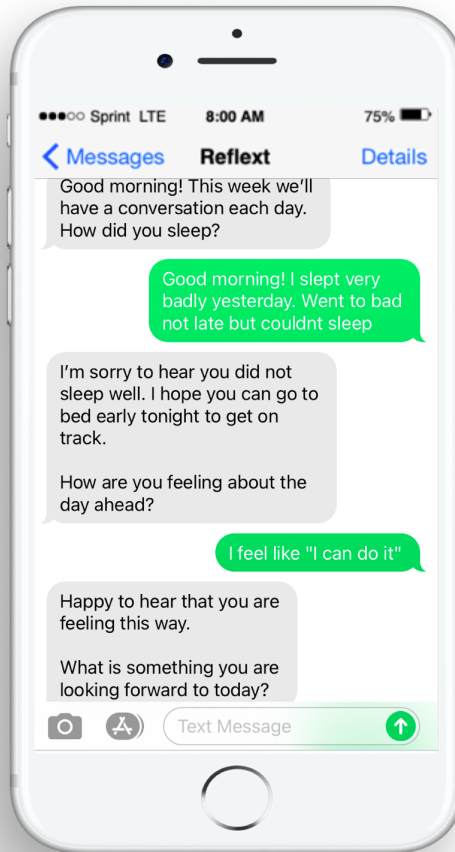


Figure 4. Reflecting through texting with Reflex.

3.2 Related Work

3.2.1 Positive Psychology Interventions

Psychology aims to decrease ill-being such as mental illnesses, while positive psychology seeks to increase well-being and enable people to *flourish*. Flourishing is defined as achieving optimal functioning,

living one's full potential. Thus, positive psychology studies positive emotions, engagement, relationships, meaning, and achievement instead of mental illnesses such as anxiety or depression. However, positive psychology interventions not only increase the mental well-being of people who do not have any psychological disorder, but also reduce depression symptoms of people diagnosed with clinical depression [23]. These characteristics make positive psychology interventions applicable for an overall university population.

3.2.2 Self Reflection, Self Awareness, and Well-Being

Self-awareness is defined as the extent to which people are consciously aware of their internal states (such as their thoughts, feelings, values, and passions) and their interactions or relationships with others. Self-awareness alleviates psychological distress, increases mental well-being and cognitive flexibility, and improves interpersonal relationships [24]. It is widely assumed that self-reflection or introspection will improve self-awareness. Surprisingly, this assumption is not always valid. In fact, self-reflection and self-awareness are negatively correlated [25]. Luckily, recent research showed that self-reflection does not work not because it is ineffective but because most people practice it incorrectly. According to Dr. Tasha Eurich, reaching self-awareness with self-reflection is possible by asking the right questions. If people ask "what" instead of "why" while introspecting, they can increase productive self-insight and decrease unproductive rumination [26]. In this study, we designed the bot primarily to ask "what" questions to prompt objective, future-focused, and empowering self-reflections.

3.2.3 Technology to Support Well-Being

There is a vast array of mental health support apps and digital services available today, thanks to the ubiquitous internet access and mobile phone usage. Research has demonstrated the efficacy of digital interventions: Both computer and smartphone mental health interventions have been proven effective for

reducing symptoms of anxiety and depression [27, 28]. Technology-mediated reflection (TMR) is found beneficial for well-being. The Echo study proved that people who recorded or reflected on their daily activities using the TMR app Echo experienced improved subjective happiness, satisfaction with life, and psychological well-being. The recording group improved their well-being by mainly discussing relationships, while the reflection group improved by talking about actions and drawing lessons for the future [29].

Emotional disclosure has been shown to yield equally positive psychological outcomes whether the disclosing person believes they are sharing with a chatbot (a computer program that simulates a human conversation partner) or a human [30]. This is powerful in that chatbots that prompt emotional self-reflection and disclosure can help people experience positive psychological outcomes on par with that of disclosing to a human.

Many of the digital mental health interventions, including ones for self-reflection, are housed in mobile phone apps. As an example, apps such as Reflectly and Question Diary provide friendly and organized interfaces for easy self-reflection. However, setting up such apps remains the biggest barrier for their usage [22].

The SMS text messaging channel is comparatively under-utilized as a means of reaching people for providing mental health support. Relying on the notification based conversation style, SMS can support more action taking steps when compared to separate apps where opening yet another new app may be an obstacle for many users. As an example, X2 AI's Tess chatbot is an SMS-based mental health chatbot that provides emotional wellness strategies and has been validated through clinical trials [31].

3.3 Design

3.3.1 Text Bot

In constructing the self-reflection prompting bot, we chose to use SMS text message delivery to ease the barrier to usage, simply having the participants text a phone number to get started. There is no need to create an account, share personal information, or worry about configuring settings. The participants are prompted twice a day - at 8am and 6pm - with questions that ask about their day. Based on their answer, the textbot will decide to answer either enthusiastically or with sympathy. After 5 questions for each morning and evening session, the textbot stops replying. An example of the conversation fragment is shown in **Table 1**.

Prompt Question	Positive Response	OR	Negative Response
Good morning! How did you sleep?	That's nice that you slept well!		I'm sorry to hear you did not sleep well. I hope you can go to bed early tonight to get on track.
How are you feeling about the day ahead?	Happy to hear that you are feeling this way.		I see that you are not feeling very positive about the day ahead. That's okay. Every day does not need to be perfect. Also, it is possible to find something that is positive today. Now, think about this...

Table 1. Example of a conversation flow segment of the morning text session. The textbot will choose between a positive and negative response based on the tone and content of the incoming text message. Detailed conversation flow is included in **Appendix C**.

We used the NLTK SentimentAnalyzer Python package to determine whether the response texts from the participants were positive or negative. Heroku Scheduler was used to schedule the morning and evening prompts and send them at the correct times. The texts were sent and received by a phone number purchased through Twilio. We connected with the Twilio API and built our response logic in Python. The responses from each participant were deleted immediately to preserve privacy, and a Heroku Postgres database was used to track the progress of their conversation.

3.3.2 Positive Self-Reflection and Well-Being Prompts

Each morning and evening session with Reflext has five prompts to answer and was designed to take around 5 minutes to complete. Each day these prompts are different, although the overall structure remains the same. During each morning session, Reflext (1) greets the participant, (2) asks four questions that aim to facilitate self-reflection, (3) provides a well-being suggestion for the day and encouragement, (4) thanks the participant for answering its questions and wishes them a good day. Each evening session, the bot (1) greets the participant, (2) asks four questions that aim to facilitate self-reflection, (3) inquires if the participant had a chance to complete that day's well-being suggestion and, if not, provides a minimum effort alternative for the participant to still have a small accomplishment and happiness increase, (4) thanks the participant for answering its questions and wishes them a good night. The order of the question about the well-being suggestion changes each day.

The self-reflection questions were designed to prompt positive reflections about the past, present, and future using earlier positive psychology and emotional intelligence research findings. These include reflections to increase self-awareness [32], anticipation [33], gratitude [34], kindness to oneself and others [35], and goal-setting [36]. These reflections also help participants draw lessons from the past for their futures [29], savor good things in their lives [37], imagine themselves at their best, identify their character strengths, and a new way of using them [34, 38].

The well-being suggestions were designed using Sonja Lyubomirsky's happiness research. Dr. Lyubomirsky's research demonstrated that twelve activity categories increase happiness. In this study, six of these activity categories were used while developing the suggestions: Kindness, taking care of your body, savoring life's joys, nurturing social relationships, avoiding overthinking and social comparison, and cultivating optimism [37].

After developing the first draft of the Reflext conversation flow, the research team tested the flow with four MIT students. The flow was enhanced with the feedback to ensure it is easy to understand and engaging.

3.4 Experimental Study

3.4.1 Participants

The target population for the study was determined as current MIT students, both undergraduate and graduate, who are 18 and older, had US phone numbers that they were willing to exchange SMS text messages on, and were interested in participating in our study and adding self-reflection to their lives. Study participants included graduate students, not only undergraduates, to increase the sample size and impact since graduate students might also benefit from the same intervention. Sixty-seven people from MIT enrolled in our study through an online sign-up form. Of those people, 57 were current MIT students and had US phone numbers. Forty-two of them completed the consent forms and filled the pre-study survey to qualify to start the study. Out of 42, 34 completed the study (22 Female, 10 Male, and 2 Non-Binary). There were 20 Bachelor's, 8 Master's, and 6 Ph.D. students. Thirteen students identify themselves as Asian/Pacific Islander, 11 as Caucasian, 4 as African American, 2 as Hispanic/Latinx, and 3 as Multiethnic. One participant preferred not to identify his ethnicity.

3.4.2 Methods

The students were recruited for the study through an email advertisement. A lottery incentive with a prize of 80\$ for six people was provided to increase the response rate. People who were qualified to participate in the study were assigned semi-randomly to Group A and Group B with some manual distribution to balance degree type (undergraduate, masters, Ph.D.), gender, and ethnicity between groups. The groups experienced different sequences of intervention and control weeks. Group A experienced full Reflexit functionality (intervention condition) in the first week while answering a basic journaling prompt by texting to the bot (active control condition) the following week. Group B started with the basic week (active control condition) and continued with using Reflexit (intervention condition) the second week. That method allowed the research team to evaluate the efficacy of Reflexit compared to answering a basic

journaling prompt in the same medium and identify a potential order effect. The participants were not informed about the two conditions to prevent participant bias.

The participants received an online consent form to sign and the pre-study survey to fill. The participants who completed this process received an onboarding email, including the importance of self-reflection, detailed instructions, and mental health resources for them. The participants sent the first text message to Reflext the weekend before the study to get an introduction message from Reflext and to allow for early troubleshooting if they did not receive a message. Participants responded to the bot's text every morning and night for two weeks. At the end of each week, they filled out a set of questionnaires. At the end of the study, they were asked to fill a brief open-ended survey to share their thoughts about the study and improvement ideas. **Figure 5** shows the study flow.

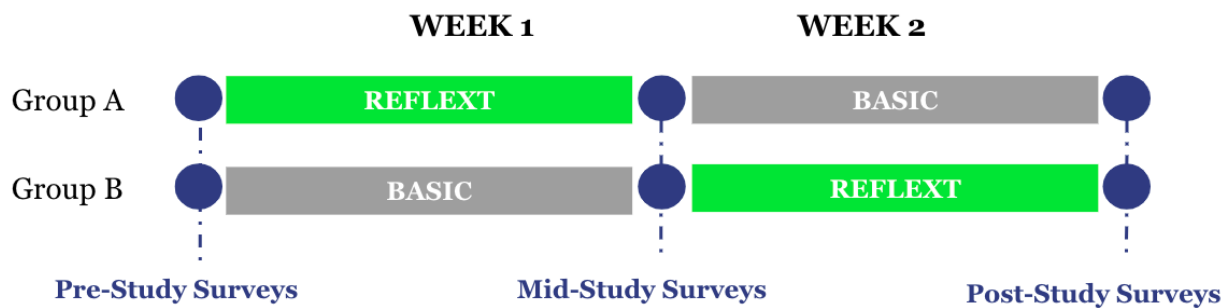


Figure 5. The study flow

3.4.3 Data Collection and Measures

Participants completed pre-, mid-, and post-study questionnaires and a brief open-ended survey. Before starting the study, the participants filled the Self-Reported Habit Index scale [39], a 12-item that was customized to measure participants' self-reflection habit strength. To evaluate the change in the participant's perception of their self-awareness outcomes, mental well-being, and stress, we asked the participants to complete three questionnaires before the study and after each of the two weeks: Self-Awareness Outcomes Questionnaire (SAOQ) [24], Warwick-Edinburgh Mental Wellbeing Scale [40], and Perceived Stress Scale (PSS) [41]. The SAOQ is a 38-item scale that includes four sub-scales to

measure four different self-awareness outcomes: Reflective Self-Development, Acceptance of Self and Others (Acceptance), Proactive at Work, and Emotional Costs of Self-awareness (Emotional Cost). SAOQ was used to understand if the study helps participants increase their self-awareness and, specifically, if it increases the positive outcomes of self-awareness instead of negatives such as guilt, fear, vulnerability, and fear coming from rumination [24]. Warwick-Edinburgh Mental Wellbeing Scale is a 14-item scale that assesses mental well-being in the general population [40]. It was used in this study to evaluate Reflexit's impact on students' mental well-being. Lastly, the PSS consists of 10-items that measure stress perceptions [41]. Stress is one of the most prevalent mental health issues at MIT [5]; thus, it cannot be ignored while creating a well-being intervention for the MIT population. We sought to evaluate how the study affects student stress levels to ensure that the team was not creating a product that adds to an existing problem.

At the end of the study, participants also responded to open-ended survey questions and shared their study experience, what they liked and disliked about it, if they would recommend it to a friend, and their improvement ideas. All questions are included in **Appendix C** and **Appendix D**, and all survey questions are included in **Appendix E**.

3.4.4 Data Analysis

Within each week, initial and post-survey scores were compared, calculating the raw changes in scores for each participant as well as finding the means of the initial and post-survey scores within each group. These averages for each group for each questionnaire were plotted, using 95% confidence interval error bars and performing a two-sided paired t-test to detect any statistically significant differences in mean scores between the initial and post-survey scores within each group. The raw changes in scores were bar-plotted to investigate the direction of change in mean scores for each questionnaire in each group.

To examine the effect of the intervention week versus the active control week across groups, the data were grouped into scores after a week of intervention and scores after a week of active control, keeping the original timestamps but ignoring the original Groups A and B. These scores for each questionnaire were fed into a linear mixed effects model (built using Python

statsmodels.formula.api.mixedlm), with the questionnaire score as the dependent variable and Time and Group (intervention or active control week data) as fixed effects while participant ID was a random effect. This modeling was done for both raw questionnaire scores and separately for changes in scores from pre-study questionnaires as the dependent variables.

The correlations between participants' engagement in the study (adherence to the study and number of responses) each week and (i) whether they were in intervention and active control week and (ii) their score changes in questionnaires were measured.

The affinity diagramming method [42] was used to organize and analyze the participants' responses to the open-ended post-survey questions about their study experience.

3.5 Results

3.5.1 Exploratory Data Analysis

Principal Component Analysis (PCA) was used to visualize the data and determine any separation between the active control and the intervention data. The difference in scores between the pre-study score and active control or intervention score was used to examine the differences for each participant. The scores were normalized to account for the different score ranges. As shown in **Figure 6**, the control and intervention data were not linearly separable. The scores did not significantly differ for participants after using Reflex.

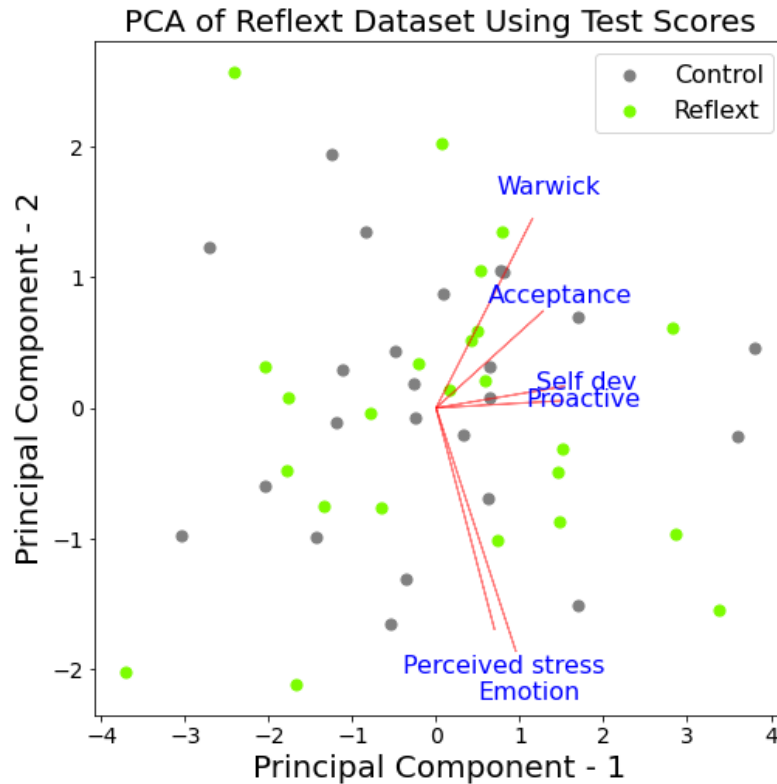


Figure 6. PCA of the difference in test scores after the active control week and intervention week.

3.5.2 Week 1 Results

3.5.2.2 Changes in Questionnaires

In week 1, Group A experienced the full Reflext chatbot experience, with 5 questions in each of the morning and evening sessions along with sentiment-informed responses. Group B experienced the active control condition of an open-ended journal prompt question delivered via text in the morning and evening. The pre-survey and mid-survey (end of week 1) scores on the various questionnaires within each group were compared. This comparison was done using a two-sided paired t-test (comparing pre- and mid-survey scores) with p-value threshold 0.05. Prior to running the t-tests, assumptions of homogeneity of variance and normal distributions of the data were checked and confirmed to hold, using the Levene and Shapiro-Wilk tests, respectively. **Figure 7** shows the Levene test statistic and p-values as well as the

Shapiro-Wilk test statistic and p-values, along with the T-statistic and corresponding p-value above each barplot.

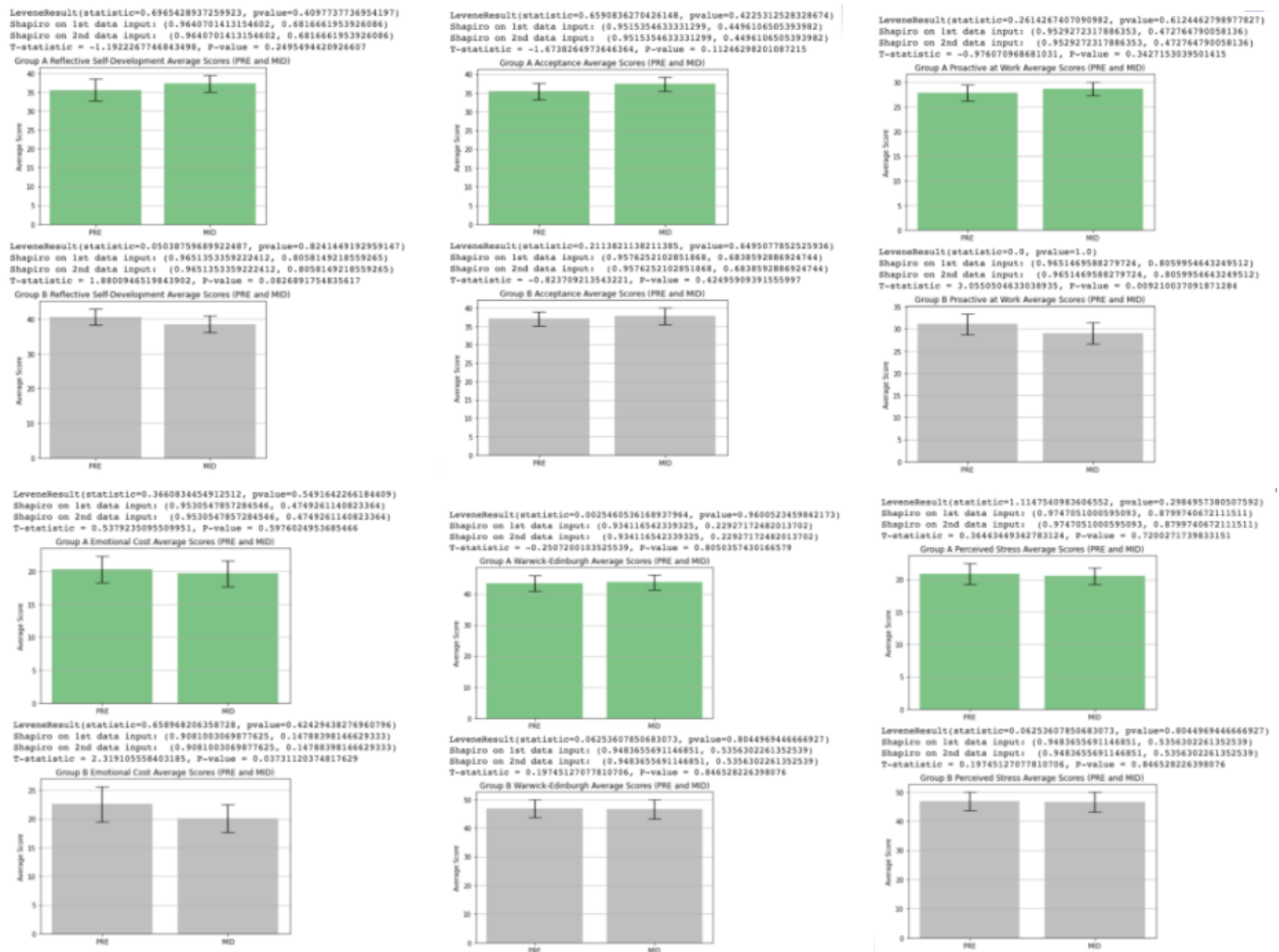


Figure 7. Barplots and p-values of week 1 results.

Group A (green barplots) had no statistically significant changes in score on the questionnaires, as judged by a paired t-test with p-value threshold 0.05, comparing pre- and mid-survey scores. Interestingly, Group B (gray barplots), the active control group) did see a statistically significant decline in Proactive at Work and Emotional Cost scores.

For Group A, on average, increased scores indicated improvement in Reflective Self-Development, Acceptance, Proactive at Work, and Warwick-Edinburgh Wellbeing scales, while decreased scores in Emotional Cost and Perceived Stress scales also indicated improvement in psychological state. However, these changes were not statistically significant. On average, Group B experienced a deterioration in Reflective Self-Development, Proactive at Work, and Warwick-Edinburgh Wellbeing while having improvements in Emotional Cost, Acceptance, and Perceived Stress scores. As noted above, only the change in Proactive at Work and Emotional Cost scores were statistically significant for Group B. **Figure 8** visualizes the average change in raw score for each questionnaire in each group.

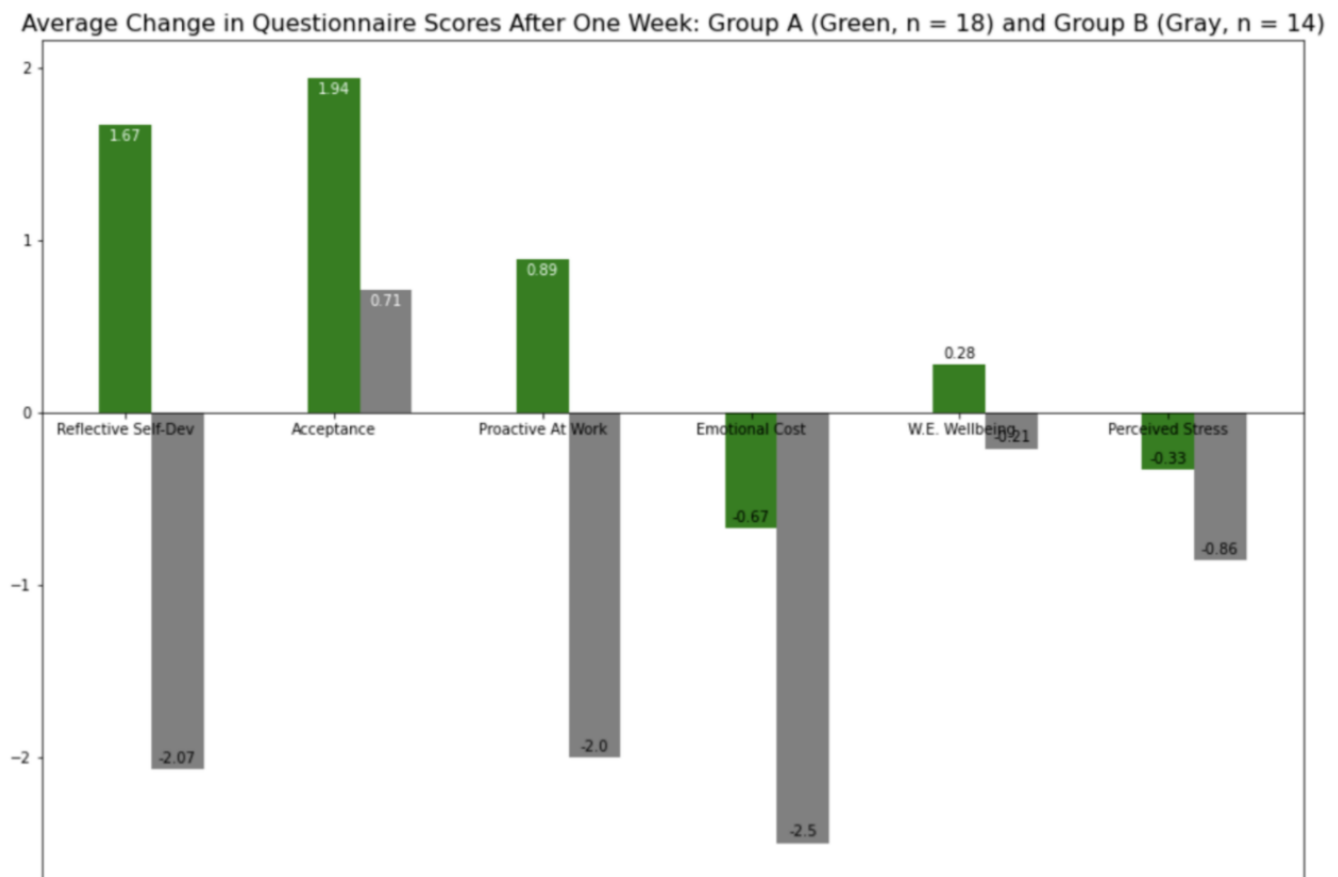


Figure 8. Average changes in questionnaire scores of intervention compared to active control after week 1.

3.5.2.2 Engagement

In week 1, Group A (intervention week) participants portrayed greater engagement in the study than Group B (active control week). In Group A, 95.24% of participants stayed in the study after the first week, whereas 85% of Group B stayed. Also in Group A, 85.71% responded to each Reflext prompts 5 days or more, whereas only 70% of Group B completed 5 days or more of journaling. These differences are not statistically significant at a 95% confidence interval.

For Group A, no relationship between the number of sessions completed and questionnaire scores was identified. For Group B, there is a negative correlation (-0.8) between the number of sessions completed and Perceived Stress Scores ($p=0.00156201$).

3.5.3 Week 2 Results

3.5.3.1 Changes in Questionnaires

In week 2, Group B underwent the full Reflext chatbot experience (plotted in green), with 5 questions in each of the morning and evening sessions along with sentiment-informed responses. Group A experienced the active control condition (plotted in gray) of open-ended journal prompt questions delivered via text in the morning and evening. The mid-survey (end of week 1, prior to start of week 2) and post-survey (end of week 2) scores on the various questionnaires within each group were compared. Neither group had any statistically significant changes in score on the questionnaires, as judged by a two-sided paired t-test with p-value threshold 0.05, comparing mid- and post-survey scores. Prior to running the paired t-test, assumptions of normality and homogeneity of variance were checked (and confirmed met) using the Shapiro-Wilk and Levene tests, respectively, with test statistics and p-values also shown on **Figure 9**.

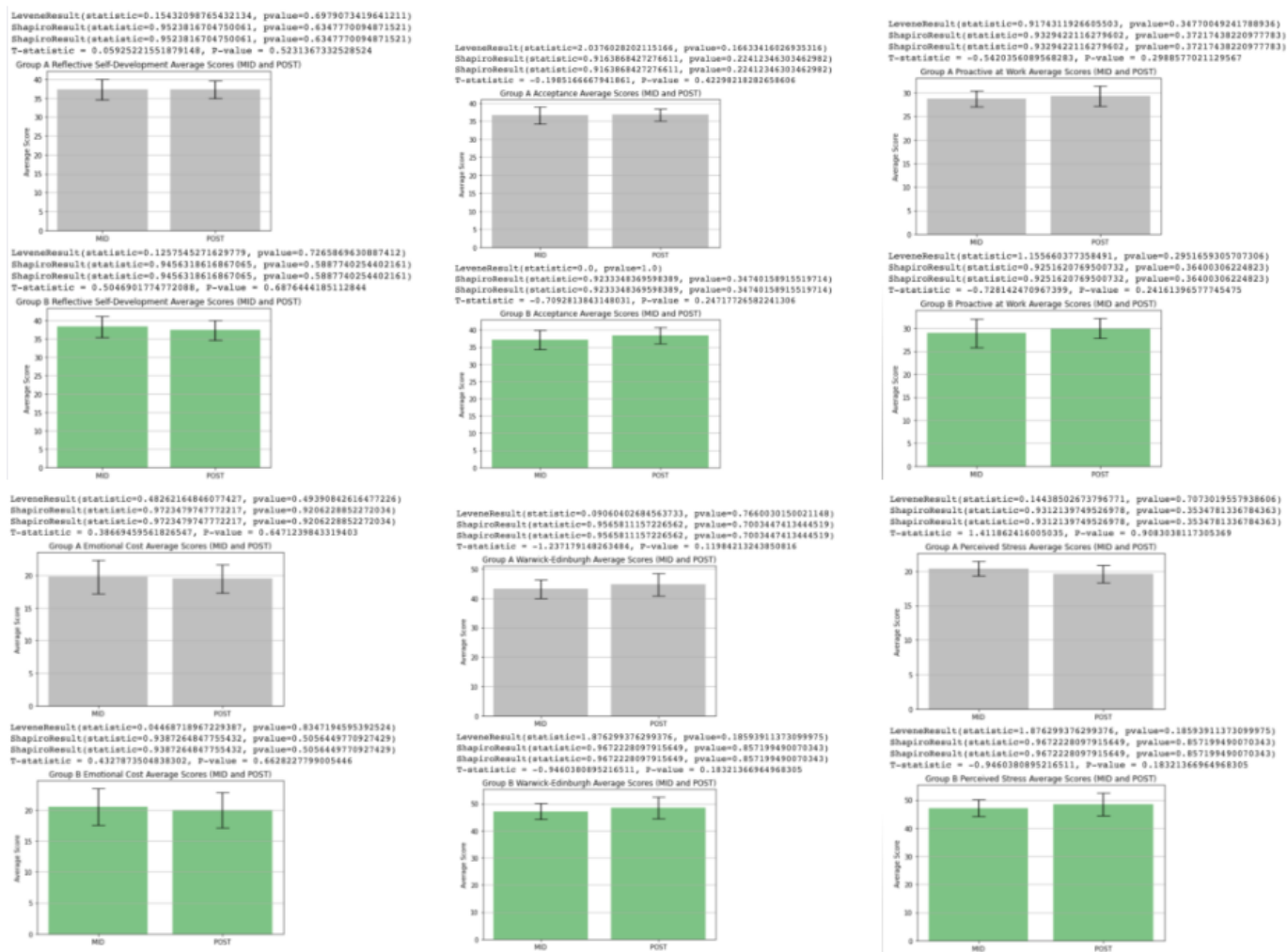


Figure 9. Barplots and p-values of week 2 results.

For Group A, on average, scores indicate declines in Reflective Self-Development, Emotional Cost, and Perceived Stress and increases in Acceptance, Proactive at Work, and Warwick-Edinburgh Wellbeing. Group B showed the same direction of average score change on all measures, except for Perceived Stress, which increased in Group B but decreased in Group A. None of these changes were statistically significant, though, as shown with the t-tests above. **Figure 10** visualizes the average change in raw score for each questionnaire in each group.

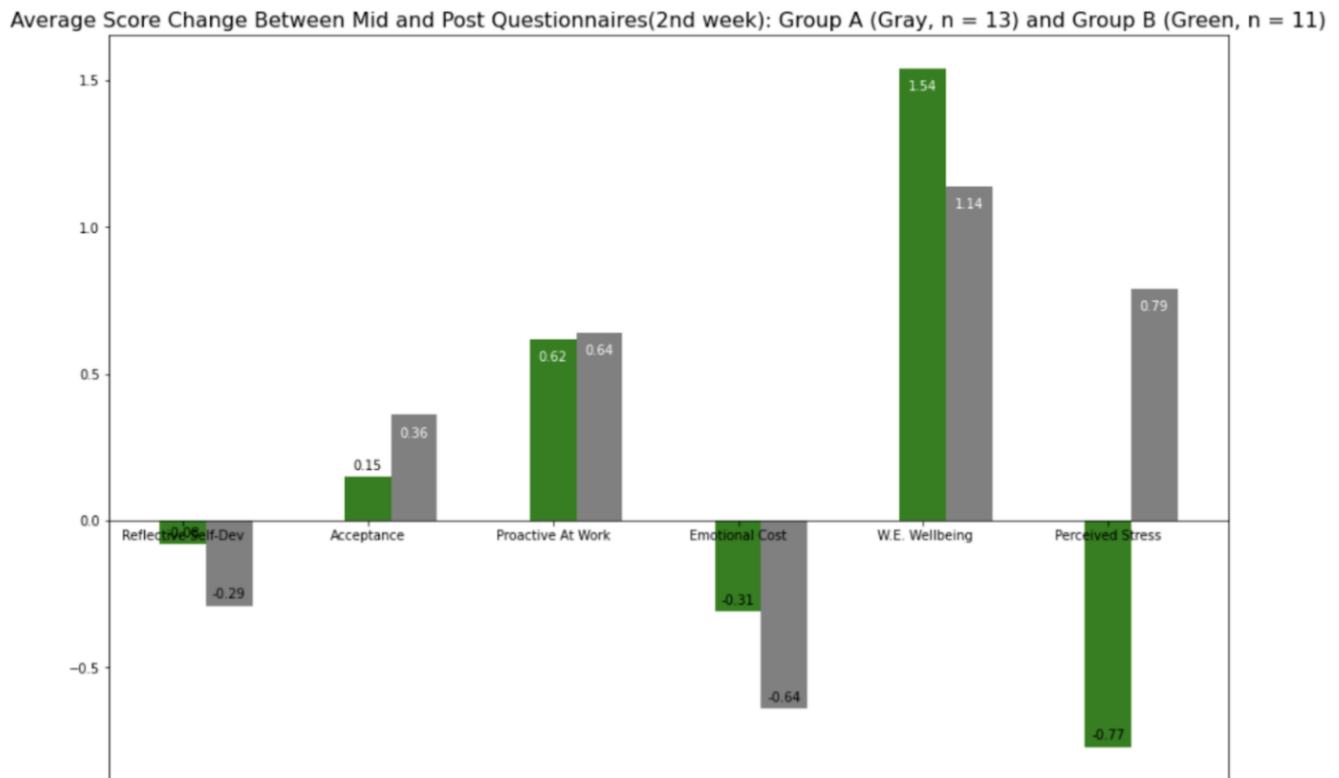


Figure 10. Average changes in questionnaire scores of intervention compared to active control after week 2.

3.5.3.2 Engagement

No difference was observed between Group A (active control condition) and Group B (intervention condition) engagement levels in week 2. However, the number of people in Group A who responded to prompts five or more days decreased 27% in week 2, when the group interacted with the basic journaling prompts, compared to week 1, when the group interacted with Reflext (88% confidence interval). Group B displayed no increase in sessions completed.

For Group B, no relationship between the number of sessions completed and questionnaire score was identified. However, for Group A, there is a negative correlation (-0.7) between the number of sessions completed and Perceived Stress Scores ($p=0.0009507$).

3.5.4 Overall Results

3.5.4.1 Intervention vs Active Control

While the aforementioned t-tests examined whether the intervention significantly changed scores within each group, the team wanted to examine whether the intervention week had an overall effect different from the active control week. To approach this question, two sets of linear mixed effect models were built for each questionnaire, with Time (end of week 1 = 1, end of week 2 = 2) and Group (if data came from the end of the intervention or active control week) as fixed effects and participant ID as a random effect. In one set of models, the dependent variable was the raw questionnaire score (Raw Score); in the second set, the dependent variable was the change in score (Score Change) versus the baseline pre-survey score. In all of these models, no significance was found for the Group variable, indicating that the intervention condition had no significant influence on questionnaire scores versus the active control. **Table 2** summarizes the models and their coefficients and p-values for the Group (intervention or active control) variable.

Model	Group Coefficient	Group p-value
Raw Score: Reflective Self-Development	-1.171	0.329
Raw Score: Acceptance	1.147	0.296
Raw Score: Proactive at Work	-0.434	0.665
Raw Score: Emotional Cost	0.552	0.623

Raw Score: Warwick Edinburgh	1.003	0.561
Raw Score: Perceived Stress	1.098	0.153
Score Change: Reflective Self-Development	0.818	0.556
Score Change: Acceptance	0.948	0.917
Score Change: Proactive at Work	1.608	0.141
Score Change: Emotional Cost	0.528	0.675
Score Change: Warwick-Edinburgh	0.045	0.972
Score Change: Perceived Stress	1.399	0.100

Table 2. The models and their coefficients and p-values for the Group (intervention or active control) variable.

3.5.3.2 Participant Experience

At the end of the study, 25 participants (69%) reported that they preferred the week in which they had a conversation with Reflext (intervention week) over the week in which they did basic journaling by texting to the bot (active control week). The top three reasons for this preference were Reflext's guidance, interactivity, and content. Out of 25 participants who preferred Reflext:

- Sixteen participants (44%) shared that Reflext's guiding prompts made self-reflecting simpler and more intuitive for them than journaling.
- Eleven (31%) shared that interactive conversations made Reflext more engaging and motivating than journaling.
- Nine (25%) mentioned that they enjoyed Reflext's self-reflection questions and well-being suggestions.

Ten participants (28%) reported that they preferred self-reflecting through doing open-ended journaling by texting to the bot (active control week) over self-reflecting through having a conversation with Reflext (intervention week). Having more control over their reflection, spending less effort, and

being able to reflect more deeply in the active control week were the top three reasons they shared for this preference. Out of 10 participants who preferred the active control week:

- Four participants (11%) noted that they preferred to reflect in a free form, and one mentioned that they liked to set their own goals for the day.
- Three participants (8%) reported that they liked to receive only two texts a day as it was less demanding than having a conversation with Reflext, which required them to respond to 10 texts a day.
- Two participants (6%) mentioned that they liked the journaling feature because it allowed them to reflect more deeply.

Only one participant (3%) was unsure about their preference.

When asked what they disliked about self-reflecting by having a conversation with Reflext, 14 participants (39%) shared that they wished they could have more control over their Reflext experience. These participants replied that they would prefer to choose the conversation topic, format, well-being activity, and/or timing of the messages themselves. For six of them (16%), Reflext's structure felt restricting and even forced for three (8%). Twelve participants (33%) reported they did not like that Reflext sometimes misinterpreted their sentiments and sent irrelevant responses. Four of them even mentioned that these mistakes annoyed or frustrated them. Three participants (8%) reported that they thought Reflext was asking too many questions.

Out of 31 participants, 15 (48%) reported that they would want to keep using Reflext - 5 (16%) for one more week, 4 (13%) for one more month, and 6 (19%) for longer. Eighteen participants (58%) reported that they would recommend Reflext to a friend.

3.6 Discussion

This study investigated the efficacy of a textbot that provides self-reflection prompts and well-being suggestions to improve college students' positive self-awareness outcomes (reflective self-development,

acceptance of self and others, and proactivity at work) and mental well-being while decreasing perceived stress and the emotional costs of self-awareness..

There are no statistically significant changes in participants' questionnaire scores after they used the full Reflext chatbot for a week. Therefore, the hypothesis that the self-reflection prompting chatbot would improve positive self-awareness outcomes and well-being while reducing emotional cost and perceived stress was not supported by analysis of the questionnaire scores. The aggregate average changes in score barplots were promising, with the Reflext group showing improvements on all psychological outcomes on average in Week 1 and improvements on four out of six psychological outcomes in Week 2, for instance. However, these changes were not statistically significant. Our experiment had a relatively small sample size, with fewer than 20 adherent participants in each group in each week.

The study assumed that using Reflext would be more engaging than answering an open-ended journaling prompt. Although the intervention group portrayed greater engagement, illustrated in the higher number of responses and study adherence in the first week, there was no statistically significant difference in engagement levels between groups. Future work could increase the sample size to test this hypothesis better.

A statistically significant negative correlation between participants' number of responses to journaling prompts and their Perceived Stress Scores was observed in both groups. This negative correlation shows that the higher engagement with the open-ended journaling might alleviate participants' perceived stress levels.

Results from the feedback section of the post-study survey suggest that Reflext provided a better self-reflection experience for most participants than open-ended journaling through texting. Participants reported that receiving guiding prompts and having interactive conversations with Reflext made self-reflection more intuitive and engaging. They also enjoyed Reflext's self-reflection questions and well-being suggestions. However, such a structure also caused some participants to feel restricted and forced in their reflections. Some participants also reported disliking times when Reflext misinterpreted their messages and sent irrelevant responses. Future work should identify methods to mitigate these pain points in the user experience. For instance, users can be given the option to choose a self-reflection topic, format, well-being suggestion, and timing of the messages for the day. Future work should also offer more

categories of responses aside from the binary positive or negative responses. Having a neutral response could avoid annoying users with a slightly too positive or negative response. Additionally, a more advanced sentiment analysis that performs better than Python's nltk could be helpful in ensuring that participant responses' sentiments are gauged appropriately.

Chapter 4

Conclusion and Future Work

This thesis included a qualitative research and design case study. The qualitative research aimed to identify the factors contributing to the high-stress levels of MIT undergraduate students and opportunities for increasing their well-being. Sixteen one-on-one interviews with MIT undergraduate students were conducted. The qualitative data analysis suggested that the main stress factors were internal, social, and academic pressure to sustain a high workload. The primary student needs were defined as pursuing their authentic success journeys by being purposefully productive, having peace of mind while doing that, being socially connected, and accessing quality support resources when they need them. High-level design opportunities for each need-theme were created to provide a starting point and inspiration for future work: a guided journal, a well-being schedule, friend-matching, and need-and-support-matching. Future work can benefit from validating the importance and intensity of each need by conducting a quantitative survey and accordingly selecting the opportunity area(s) to focus on. Future research could further explore the selected opportunity areas through ideation workshops with students and well-being experts at MIT and a quantitative survey could prioritize the created ideas.

This study prioritized the guided journal and well-being schedule ideas as most of the research participants reported related needs and expressed intense emotions in related conversations. This method was the most feasible option with the given time constraints. The second part of the study aimed to create and test a minimum viable product by combining the critical parts of these prioritized ideas.

A chatbot was designed to provide self-reflection prompts and well-being suggestions to improve college students' self-awareness and mental well-being. The active control condition provided an open-ended journaling prompt through text. Thirty-four MIT students completed our study, and 24 of them were entirely adherent in both weeks of the study. The participants were asked to respond to the

chatbots' prompts for a minimum of five days, morning and night, for each of the two weeks. The Reflext group showed improvements on all psychological outcomes on average in week 1 and showed improvements on 4 out of 6 psychological outcomes in week 2. However, these improvements were not statistically significant. We did not find statistically significant improvements compared to the active control condition either. Future work should increase the sample size and duration of the study to more effectively test the efficacy of the intervention.

Qualitative analyses of the post-study survey data suggest that most participants preferred self-reflection with Reflext over journaling through texting, as they appreciated Reflext's guiding prompts, interactivity, and well-being suggestions. The data revealed that some participants needed to have more control over their self-reflection experience and be better understood by Reflext. Future work in this area should allow users to customize their self-reflection experiences and should provide a more advanced sentiment analysis and relevant responses to different sentiments, including neutral ones, to satisfy identified needs. The study was conducted during the end of the semester when students typically are busier, and their well-being declines [43]. Future related studies may select a different time (i.e., beginning or middle of the semester) to conduct the study to increase participant adherence and better evaluate the impact of Reflext.

The qualitative research highlights the four main need themes related to well-being for the undergraduate students at MIT. These are authentic journeys; peace of mind; social connection; and support, including awareness, access, and quality. The case study highlights the opportunity to use SMS as an engaging self-reflection and well-being tool.

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Appendix

Appendix A: Mass Recruitment Email

The mass recruitment email that was sent to undergraduate dorms to recruit students from diverse backgrounds.

Hello everyone!

I am an MIT graduate student researcher who is doing qualitative research to understand the stress factors for MIT's undergraduate students and how their well-being can be improved. I am looking to talk with undergraduate students from different academic study years, majors, ethnic backgrounds, religions, and nationalities to learn about their experiences at MIT.

The interviews will be conducted over Zoom and will take approximately one hour. All the information shared will remain anonymous.

If you are interested in participating in the research or have questions about the research, please reach out to me via nazli@mit.edu.

I look forward to hearing from you!

Best,

Nazli Ece Usta

Appendix B: Interview Protocol

This interview protocol was prepared to be a guide to the researcher. The researcher customized and skipped some of the questions and added other questions during the session in response to the flow of the conversation with the participant.

Introduction & Consent

First of all, thank you very much for your time. The purpose of my research is to understand in-depth the stress factors for undergraduate students and how their well-being can be improved. I hope to contribute to the understanding of student wellbeing at MIT and also create solutions to increase student well-being.

Can I record our interview to later gather my notes? Your information will be kept anonymous.

Warm-Up

- How are you?
- Where are you right now?
- You are in the ... program and ... year student, is that right?

Card Sorting

- How would you describe your overall mood at MIT right now?
- Please describe why you chose each of these moods. When was the last time you felt ...?
- How would you like your mood to be at MIT? Why did you choose that one? Tell me more?
- When do you feel ... in your life?

Pre-Experience

- Tell me briefly about your journey to MIT? What made you decide to come to MIT?
- What was your expectation about MIT before coming here?

Experience

- How did you find MIT when you first came here?
- What do you enjoy the most about MIT?
- What do you least like about MIT?
- What are the stress inducing factors for you in your MIT experience?
- Can you tell me about a day you were most stressed at MIT?
- What are your sources to deal with stress?
- How did the pandemic affect your experience at MIT?
 - Classes?
 - Social life?
 - Emotions?
 - Stress levels?
- Can you walk me through your typical weekday?
 - When do you wake up, sleep?
 - What activities do you do?
 - Where do you spend your time?
 - Who do you interact with?
- What about weekends?
- What made you feel stressed this week?

Future

- What are your goals after MIT?
- How MIT is helping and not helping to reach your goals?

Improvement

- Is there anything in your lifestyle that you would like to improve?
- What do you think should be improved in MIT undergraduate experience?

Closing

- Is there anything we have not touched on that you want to share about your experience at MIT?
- Can I reach out to you again in the future if I have an additional question or to test my ideas with you?

Thank you very much for sparing your time for the interview. Your answers were very insightful and would help my project greatly!

Appendix C: Reflext Conversation Flow

The detailed conversation flow of the intervention week. The Reflext textbot chooses between the positive (blue) and negative (red) response based on the tone and content of the participant's text message. Some questions only have a neutral response.

Monday morning (theme: kindness)

Good morning! It's Reflext. This week we'll have a conversation. I'll ask you five questions each morning and evening. Please take time to read each question carefully, look into yourself, and share with me your self-reflection.

How did you sleep?

- I'm sorry to hear you did not sleep very well. I hope you can go to bed early tonight to get on track.
- It's nice that you slept well!

How are you feeling about the day ahead?

- I see that you are not feeling very positive about the day ahead. That's okay. Every day does not need to be perfect. Also, it is possible to find something that is positive today. Now, think about this:
- Happy to hear that you are feeling this way.

What is something you are looking forward to today?

- Thanks for sharing.

What is one small thing that you can do for yourself today? For example, you could go out to have some fresh air, make a cup of tea, or read a few pages of a good book.

- If you want, I can suggest a quick activity that is scientifically proven to increase your wellbeing!
- That sounds great! You are doing an awesome job taking care of yourself.

A wellbeing challenge for you today - Do 3 acts of kindness. These can be small acts like smiling at a stranger or listening to a friend more carefully than usual. Will you give it a try?

- If you don't like the idea of the 3 acts of kindness today, perhaps try just one act of kindness for yourself. Be more forgiving to yourself today and give intentional rests during the day to celebrate your progress.
- Awesome! Hopefully spreading kindness helps you and others feel good today.

Thanks for checking in this morning! I'll be back in the evening to see how your day went and, if you like, to talk about your acts of kindness.

Monday morning (theme: kindness)

Hi there! How are you feeling right now?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Sorry to hear you're not feeling the best.
- Sounds like it was a pretty solid day.

Reflecting on our feelings and what makes us feel in a certain way increases our self-awareness. Let's reflect on your current feelings. Why do you think you are feeling this way right now?

- Thank you for answering that!

What was the best part of your day today? Why?

- Thanks for sharing with me :)

Did you try doing some act(s) of kindness today? Yes/No? If yes, please also share with me what you did and how it made you feel?

- It can be hard to remember to do these little positive things in the midst of a busy day. Take a breath now for a second and think something positive about yourself. That counts as an act of kindness for you! :)
- Wonderful!

What is one thing you love about yourself?

- You are lovable!

Thanks for taking the time to tell me a little bit about your day and how you're feeling. Hope you sleep well tonight!

Tuesday morning (themes: taking care of your body & savoring life's joys)

Good morning! Did you sleep well last night?

- Oof... sorry to hear it wasn't your best night of sleep. Opening a window and having some fresh air can help you feel refreshed.
- Glad to hear you rested well.

What's on your mind right now?

- Sounds like your mind is busy, perhaps with some worries. I hope you feel more settled as the day goes on. I'll check in later.
- Thanks for sharing! I hope that your mind feels clear and content as the day progresses.

How do you hope to feel at the end of the day? (You can define your own feelings or prefer to choose one of these: Calm, joyful, loved, proud, motivated, excited, inspired, hopeful, amused, grateful)

- Thanks for reflecting on that. Sometimes it makes sense to think backwards so you can make sure

your plan for the day is working toward that goal.

What is one thing you can do today that will help you feel this way?

- Thank you for sharing this with me.

Do you think you'll be able to make time to go outside today, even if just for a little bit? It can be really rejuvenating!

- I would challenge you to step outside for just 2 minutes today! Just 2 minutes, that's it! Put a good song on and take a few breaths as you look at what is around you.
- Great! Really try to take in the outdoor atmosphere with all of your senses when you get outside. Find three things (anything!) that make you feel good or experience awe.

Thanks for chatting this morning. Have a great day, and I'll be back later to see how your day turned out, hopefully you'll report a bit of time outside!

Tuesday evening (themes: taking care of your body & savoring life's joys)

Were you able to get outside today, even for just a minute or two?

- That's okay. Hopefully tomorrow you can make the time to get outside, even if just for a little bit!
- Wonderful! I hope it was relaxing and refreshing.

What three things made you feel good today?

- Thank you for sharing!

Do you feel now as you had hoped to feel at the end of your day when I asked you this morning? (If you don't remember, you can scroll up to see your response from the morning)

- Unexpected things can pop up, and days don't always turn out as we plan. But setting intentions and hopes is still worthwhile.

- I'm glad to hear that you are feeling similarly to as you had hoped. Setting intentions at the start of the day can help guide us.

What's something (anything) you want to work on tomorrow?

- Thanks for reflecting on that. I hope that tomorrow you can keep that goal in mind.

Will you be able to head to sleep at a good time tonight in order to give yourself the rest you need for the next day?

- Sometimes we all lose a little sleep, but I hope that you can try to give yourself a bit more time to sleep, even if it's just 10 minutes.
- Good job prioritizing your health. Sleep is such an important foundation for your wellbeing!

Hope the rest of your evening goes well! I'll check in tomorrow morning.

Wednesday morning (theme: savoring life's joys)

Good morning! Did you wake up this morning feeling rested?

- If you like, a little stretch can get you feeling more energized for the day ahead.
- Happy to hear you are feeling rested. Hopefully that gives you great energy in the day ahead!

What is a goal that you want to accomplish today?

- Thank you for sharing! Goal setting helps you prioritize your time according to what matters the most for you.

What can you do to achieve this goal today?

- Great! Feel free to revise the plan and the goal today as you figure out what works for you. I'm excited to hear later tonight how your goal turns out today.

If you have a minute or two now, reflect on a positive experience you've had. Replay this positive experience in your mind for a little bit. Once you're done, let me know... did it feel nice?

- With practice, these kinds of visualizations can be really helpful to improve mood and focus.
- Visualizations like this can feel really nice, and they are accessible to you in your mind at any time!

Are you feeling ready for the day ahead?

- Sometimes things can feel overwhelming in the morning. If that sounds like how you are feeling right now, here is a 3-steps suggestion: 1) Think of the most stressful thing on your list of things you will do today. 2) Reflect on what's one thing you can do to help it move forward. 3) Try to do it as soon as possible. You got this!
- Sounds like you are ready to roll!

Thanks for setting a goal and trying out the visualization this morning. Talk to you later!

Wednesday evening (theme: savoring life's joys)

Hi! How was the day?

- Thanks for being honest.
- I'm happy to hear that you had a nice day.

Tell me more. What made it that way?

- (Their response doesn't matter...)
- Thank you for sharing!

This morning, you set a goal. Do you feel like you have progressed on your goal today?

- Okay, it happens to the best of us. There's always tomorrow!

- I'm glad to hear that!

What is something that you learned today (doesn't have to be academic)?

- (response doesn't matter)
- It's cool how there is learning in all things, both positive and negative.

Okay now don't worry about offending me... have my texts felt helpful at all to you so far?

- Thanks for your honesty there. Hopefully I can improve!
- Yay! That is great to hear, and I hope I can continue supporting and encouraging you even more.

Thanks for chatting with me, hope you get a good night's rest this evening!

Thursday morning (theme: nurturing social relationships)

Good morning! How are you feeling this morning?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Sorry to hear that you are not feeling your best this morning. A healthy breakfast may get you feeling way better and more energized for the day ahead.
- Happy to hear you are feeling good this morning!

How do you hope to feel at the end of the day? (You can define your own feelings or prefer to choose one of these: Calm, joyful, loved, proud, motivated, excited, inspired, hopeful, amused, grateful)

- Reflecting on how you want to feel at the end of the day can help you be more intentional about how you are showing up for the day.

Let's think now. What is one thing you can do today that will help you feel that way?

- Thank you for sharing it with me.

Think about people you care about. Who are the first people who came to your mind?

(no response, directly asks the next question after the participant responses)

I have a wellbeing challenge for you to nurture your social relationships - Call/text someone you care about today and show interest in the good things going on in their life. Ask questions, get excited for them, and even offer to celebrate their achievements if you think that is appropriate. Will you give it a try?

- If you don't prefer to have a long conversation with someone today, perhaps try to check in with them by texting "Hello, how is everything going?" and show them that you care about them. Our relationships are essential for our wellbeing.
- Awesome! Hopefully, this will nurture your relationship with that person even more. We can talk about it at the end of the day.

Thank you for talking with me. You can let me know how it went and how it made you feel at the end of the day!

Thursday evening (theme: nurturing social relationships)

Hello! How are you feeling this evening?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Thank you for your honesty. You're not alone feeling this way.
- Happy to hear you are feeling good this evening.

Reflecting on feelings and what makes one feel a certain way increases our self awareness. Let's reflect on your current feelings. What mainly makes you feel that way this evening?

- Thank you for answering that.

Did you have a chance to try nurturing your relationship with someone you care about today? Yes/No? If yes, please also share with me how it went!

- I know that sometimes schedules get busy and you might de-prioritize spending time with people we care about. It is totally okay. This evening, just try to reflect on a person you are grateful for.
- That is great to hear that you took the time to check in with someone you care about today! Our relationships are essential to our wellbeing. By prioritizing your relationships, you are not only nurturing your relationships but also increasing your quality of life.

What is one thing you are grateful for about this person?

- (no response, directly next question)

What one thing brought you a sense of delight today?

- I am very grateful that you shared this with me.

Thanks for chatting with me. I hope you get a good night's rest this evening!

Friday morning (theme: avoiding overthinking & social comparison)

Good morning! How are you feeling this morning?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Oh, sorry to hear that. Sipping some water can get you feeling better and more energized for the day ahead.
- I'm happy to hear you are feeling good this morning.

What are your top 3 goals for the day? Think about the goals that are most meaningful to you and small enough to be feasible to achieve during the day. If you have a long term goal you want to work towards

today, think about a small piece you can bite off of it today. Your goals can be about your work, extracurriculars, relationships, wellbeing, or any other thing that you choose.

- Great job setting goals!

How can you manage your time to prioritize achieving these 3 goals today?

- Prioritizing is a great strategy to achieve the most important things. Great job doing it!

How are you going to celebrate your progress towards your goals today?

- Sounds great!

I have a suggestion to help you feel calm whenever you need it during the day- Find a quiet place where you can be alone and comfortable. Close your eyes (if you feel comfortable) and take 5 big breaths, breathing in through the nose (counting for 6) and out through the mouth (counting for 6). That is it! Will you do it today?

- If you cannot find a place you will be alone, you can try listening to your breaths wherever you are anytime. Try to take just 3 intentional breaths today.
- Fantastic! Hopefully, this will increase your mindfulness during the day. We can talk about your experience at the end of the day.

Thank you for checking in with me this morning. I will talk to you later today!

Friday evening (theme: avoiding overthinking & social comparison)

Good evening! How are you feeling after the day?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Thank you for your honesty. You're not alone feeling this way.
- It's nice to hear you are feeling that way this evening.

Let's reflect on your feelings. Why do you think you are feeling this way right now?

- Thank you for sharing your day and feelings about it with me.

What is one thing you achieved today? It's okay if it's a small thing. Also, don't forget that progress is an achievement too (a big one)!

- Great job working on your goals! You should be proud of yourself. Do something to celebrate your progress if you haven't already today... Short on time or need a suggestion to celebrate yourself? Say "You are awesome!" to yourself out loud or in your head and then hug yourself.

What can you do better tomorrow?

- Thank you for reflecting on this!

Did you have a chance to try the mindful breathing exercise today? Yes/No? If yes, how did it feel?

- No worries at all. If you like, you can take just 3 deep breaths now, breathing in through the nose and out through the mouth.
- You are awesome! If you'd like, you can make sparing a minute or two for mindful breathing a daily habit and add greater calmness and focus to your life.

You did a great job on progressing towards your goals and celebrating yourself today. I look forward to chatting tomorrow! Rest well tonight!

Saturday morning (theme: taking care of your body)

Good morning! How would you describe your mood this morning?

(You can define your own mood or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- I hear you. If it is possible for you to step into the sunlight, that can help signal to your body that it's time to wake up and give you positive energy.
- Happy to hear you are feeling good this morning.

Reflect on how you felt in the mornings this week. You can check our earlier conversations if you need to remember. What do you think helps you feel the best in the mornings?

- Thank you for answering that.

What can you do this morning to make yourself happier?

- Awesome!

What do you look forward to today?

- Let's change that!
- That's exciting!

Today's wellbeing challenge is finding opportunities to move your body and have fun. A great way to do it is by playing your favorite song and dancing along with it! Will you do it today?

- If you like, you can try doing any physical activity you prefer just for 1 minute today. Any minute moving your body is better than not moving it at all. You can even squat while brushing your teeth. Feel free to be creative to save time or make it more enjoyable for you!
- Yay! Hopefully, this will energize you and boost your mood. We can talk about it at the end of the day.

I am excited about the day ahead of you. Talk to you in the evening!

Saturday evening (theme: taking care of your body)

Good evening! How would you say your Saturday has been?

- Sorry to hear that. Taking a minute now to breathe deeply can help you calm down and recharge. Breath through the nose (counting for 6) and out through the mouth (counting for 6).
- I'm happy to hear you had a good day.

What did you do today?

- Thank you for sharing with me about your day.

What are the three things that went well today, and why did they go well?

- Amazing! Did you know that simply answering this question can make you happier? If you enjoy it, you can try doing it a couple of times every week.

Did you try moving your body today? Yes/No? If yes, how did it feel?

- You can still do it now! If that still does not work for you today, no worries at all. I hope you can find a way to move your body tomorrow.
- Awesome! Moving your body is a great way to take care of yourself and boost your mood.

What are some ways you can include physical activities in your daily routine?

- Thank you for reflecting on that!

Have a great rest of your evening. Talk to you tomorrow!

Sunday morning (theme: cultivating optimism)

Good morning! Let's make today a good one :) How did you sleep?

- Sometimes it's easy to feel tired in the morning. I hope that this chat will increase your energy level this morning.
- I'm glad to hear you rested well. You're already winning the day!

How's the weather looking? Do you think you'll be able to make time to go outside today?

- Maybe tomorrow...
- Nice! I hope you can savor your time outside.

Let me ask you an exciting question: What are your dreams? (If you find it hard to answer, you can text the first things that pop into your mind and continue reflecting on this today.)

- Thank you for answering that.

Which dream(s) are you focusing on today?

- You can do this!

Here is my wellbeing challenge for you to help you cultivate optimism - Imagine your best possible self in a year from now. Everything has gone as well as it possibly could. You worked hard and succeeded in accomplishing all your goals. Write this scenario in a journal or a note in your phone. Will you do this today?

- I challenge you to try doing this exercise for only 1 minute and see what comes to your mind first!
- I can't wait to talk with you about it tonight!

I hope you'll have a dreamy day today! I'll talk to you this evening!

Sunday evening (theme: cultivating optimism)

Hi there! Good evening. How are you feeling this evening?

(You can define your own feelings or prefer to choose one of these: Calm, happy, loved, proud, motivated, excited, anxious, stressed, angry, depressed, sad, tired)

- Sorry to hear that. Taking a minute now to breathe deeply can help you calm down and recharge.
- I'm happy to hear you are feeling good this evening.

Why are you feeling this way?

- Thank you for sharing this.

Did you try imagining your best possible self in a year from now on today? Yes/No?

- No worries. I hope you can try it another time that works for you. It is a great way to cultivate optimism and help you reflect on how you can make that future come true starting today.
- Good job! Reflecting on your best possible self is a great way to cultivate optimism and reflect on how you can make that future come true starting today.

Recall times in the past that you accomplished things that you are proud of. What is one of these accomplishments?

- I'm proud of you!

What skills helped you to achieve it?

- Amazing that you have these skills! In the upcoming days, you can think about new ways you can use these superpowers in your life.

Thank you for staying in touch this week and adding self-reflection to your daily routine! You progressed so much in your self-awareness journey and on prioritizing your wellbeing. You should be proud of yourself!

Appendix D: Active Control Flow

The flow of the active control week in which the participants journal through texting.

Monday (first) morning

This week, I'll be your journal. I'll ask you only one question each morning and evening. Please spare ~5-10 minutes to answer my morning and evening prompts, reading the prompt carefully, reflecting, and responding thoughtfully. Please respond here about how you are feeling and your goals & plans for the day ahead.

Other mornings

Please respond here about how you are feeling and your goals & plans for the day ahead.

- Thank you for sharing. Have a good day!

Evenings

Please respond here about your day, thoughts, and feelings.

- Thank you for sharing. Have a good night!

Appendix E: Questionnaires

Self-reported habit index, for self-reflection habit

(1/4) Self-reflection habit

What is self-reflection?

In this study, we use the "self-reflection" term as the extent to which an individual pays attention to their internal states (feelings, thoughts, needs, etc.), behaviors, and interactions/relationships with others.

The following statements concern your self-reflection practice. Please indicate how accurately each statement describes you.

There are no "right" or "wrong" answers, so select the number that most closely reflects you on each statement. Take your time and consider each statement carefully. Once you have completed all questions click "Next" at the bottom.

Self-reflection is something ... *

	Strongly disagree	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree	Strongly agree
I do frequently.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do automatically.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do without having to consciously remember.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
that makes me feel weird if I do not do it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do without thinking.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
would require effort not to do it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

that belongs
to my daily
routine.

☐☐☐☐☐☐☐

I start doing
before I
realize I'm
doing it.

☐☐☐☐☐☐☐

I would find
hard not to
do.

☐☐☐☐☐☐☐

I have no
need to think
about doing.

☐☐☐☐☐☐☐

that's
typically 'me'.

☐☐☐☐☐☐☐

I have been
doing for a
long time.

☐☐☐☐☐☐☐

Self-awareness outcomes questionnaire (SAOQ)

The original question is customized to ask about the experience over the last week.

(2/4) Self-awareness outcomes

The following statements concern different outcomes associated with self-awareness. Please indicate how often you experience each outcomes over the last week.

There are no "right" or "wrong" answers, so select the number that most closely reflects you on each statement. Take your time and consider each statement carefully. Once you have completed all questions click "Next" at the bottom.

Please indicate how often you've experienced each outcome over the last week.

★

	Never	Rarely	Sometimes	Often	Almost always
I've felt guilty for criticizing others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been consistent in different situations or with different people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've thought about how as colleagues or peers we interact with each other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've recognized the stress and worry in my current work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've thought about how my personality fits with my work role	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I have had to revisit difficult past experiences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've focused on ways of amending my behaviour that would be useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been confident	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've learnt about myself and how I see the world	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've had fun	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've felt vulnerable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've felt generally positive about self-awareness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been realistic about myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've taken control of my work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've reassessed my own and others' responsibilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been aware of my abilities and limitations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've felt exposed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I've understood my emotions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been content with my work situation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've understood myself well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've found it scary to try something new or step out of what I know	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've had compassion and acceptance for others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've found making changes has been difficult and scary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've felt my emotions deeply	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been objective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been continuing to work on and develop myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've looked at why people act the way they do	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've seen my work life as something I have power to affect	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I've had insight into myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've stopped and thought before judging	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've been reflective	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've felt on the whole very comfortable with the way I am	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've been able to "take a step back" from situations to understand them better	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've had a good self-image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've changed the way I work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've understood how I work within a team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've interacted well with colleagues or peers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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I've "observed" myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Warwick-Edinburgh mental wellbeing scale (WEMWS)

The original question is customized to ask about the experience over the last week.

(3/4) Warwick-Edinburg mental wellbeing scale

Below are some statements about feelings and thoughts. Please select the answer that best describes your experience of each over the last week.

Once you have completed all questions click "Next" at the bottom.

Please select the answer that best describes your experience of each over the last week. *

	None of the Time	Rarely	Some of the Time	Often	All of the Time
I've been feeling optimistic about the future	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been feeling useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been feeling relaxed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been feeling interested in other people	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've energy to spare	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been dealing with problems well	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been thinking clearly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've been feeling good about myself	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I've been
feeling close
to other
people

☐☐☐☐☐

I've been
feeling
confident

☐☐☐☐☐

I've been able
to make up
my own mind
about things

☐☐☐☐☐

I've been
feeling loved

☐☐☐☐☐

I've been
interested in
new things

☐☐☐☐☐

I've been
feeling
cheerful

☐☐☐☐☐

Perceived stress scale (PSS)

The original questions are customized to ask about the experience over the last week.

(4/4) Perceived stress scale

The questions in this scale ask you about your feelings and thoughts during the last week. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

Once you have completed all questions click "Next" at the bottom.

In the last week, how often have you been upset because of something that happened unexpectedly? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt that you were unable to control the important things in your life? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt nervous and "stressed"? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt confident about your ability to handle your personal problems? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt that things were going your way? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you found that you could not cope with all the things that you had to do? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you been able to control irritations in your life? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt that you were on top of things? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you been angered because of things that happened that were outside of your control? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

In the last week, how often have you felt difficulties were piling up so high that you could not overcome them? *

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Fairly often
- ☐ Very often

Feedback questions in the post-study survey

Feedback

We'd love to hear your thoughts about the study. Please let us know if you have any clarifying questions about these questions by email (nazli@mit.edu). We'd love to help!

You had two different experiences with Reflext in the past two weeks: Reflext 1-Journaling and Reflext 2-Conversation with Reflext. Which one would you prefer? *

☐ Reflext 1-Journaling

☐ Reflext 2-Conversation

☐ Not sure

How would you compare your experience with Reflext 1 and 2? *

Your answer _____

Now, only think about Reflext 2. What did you like and dislike about Reflext 2? *

Your answer _____

Would you want to keep using Reflext 2? If yes, for how much longer? *

- ☐ Yes-for one more week
- ☐ Yes-for a full month
- ☐ Yes-for longer
- ☐ No
- ☐ Not sure

Would you recommend Reflext 2 to a friend? *

- ☐ Yes
- ☐ No
- ☐ Not sure

(Optional) Is there anything else you'd like to share with us?

Your answer _____