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Engaging Teenagers in Asynchronous Online Groups to Design for Stress Management

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Abstract

Teenagers have unique needs for mental wellbeing that can be supported by interactive technologies. Teens also have valuable input in the design of technology, so designers and researchers must seek new methods for involving them in the design process. We enrolled 23 unacquainted teenagers in an Asynchronous Remote Communities (ARC) study consisting of two private online groups. Teens participated in 10 weekly design activities on stress management across three months. We found that teens sought support from technology tailored to their perception of control in stressful contexts, developing sense of self, and varying social needs, including asking for no intervention from others. Teens appreciated that the ARC design experience allowed for flexibility in participation and supported selective disclosure. However, there were limited interactions between teenagers online. Reflecting on our study, we provide design implications for tools to support teenager mental health and discuss how the ARC method can be adapted for designing with teenagers.

Keywords

Teenagers; mental health; stress; asynchronous remote communities

INTRODUCTION

The mental health needs of teenagers, who are transitioning from childhood and seeking independence, are unique. Teens are under stress from multiple external sources such as school, family life, work, and peers [39]. At the same time, they do not have as many

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SELECTION AND PARTICIPATION OF CHILDREN

We invited children (13–17 years age) to participate in an online study to design for stress management. We recruited through the Reddit group [r/teenagers](https://www.reddit.com/r/teenagers), researchers' social networks, and distributed flyers to students outside high schools and around university campus. We sent online assent forms and group guidelines to all interested teenagers. In the assent forms, we informed them about the tasks in the study, data confidentiality, risks, and asked them to indicate if they agree to participate and share their quotes and/or images for research publications. To include 2 adolescents whose parents were unreachable, we obtained a complete waiver of parental permission from the IRB. We compensated participants every two weeks with \$5 gift cards per week for 20 minutes of activity time.

experiences or may not be as resourceful as adults in coping. Stress reported by teens in the United States is higher than adults, and teens are more likely to develop unhealthy coping habits [8]. Teenagers' individual preferences also vary depending on their socio-cultural influences, which may lead to inter-generational differences with non-peers in their social circle. These differences can make it difficult for adults, such as parents or school staff, to relate to and support teens even though such support is necessary [39].

Technologies can support teens in developing more self-reliant coping strategies as well as connect them with other individuals for support in both online and collocated spaces, as well as scaffold that support. However, mental health technology has been designed and developed primarily for adults [20]. It is important to involve teenagers in formative research to design technologies for mental health. Researchers have conducted participatory design sessions with teens on physical health [12]. Fewer studies in HCI or IDC focus on designing for stress and mental health to understand the unique needs of teens and how they might be supported using technologies (e.g., [32, 38]). In addition, the sensitive nature of this area of design can require methods for participation where flexibility and anonymity are built into the approach.

Both teenagers and researchers experience challenges in access and scheduling when involving teenagers in design studies [30]. The method of Asynchronous Remote Communication (ARC), in which participants are enrolled in private Facebook groups, has been used in HCI to understand needs of vulnerable and geographically distributed populations of adults. These populations include adults with rare diseases [23], people living with HIV [24], and pregnant women [31]. In this paper, we describe our use of the ARC method to engage teenagers—who have time, financial, or logistical constraints—to participate in design-based research. In this study, we answered the following research questions:

- RQ1: What needs do teenagers envision for support with stress management?
- RQ2: How might technologies support needs of teenagers for stress management?
- RQ3: What are opportunities and challenges in using asynchronous online groups as a method to engage teenagers in designing for well-being?

We enrolled 23 teens in two private online groups on a social media platform popular in work places, Slack, which allowed them to participate anonymously. The teens were asked to participate in weekly design activities for 10 weeks, entry and exit surveys, and exit interviews. Our results indicate that technology for stress management need to be designed based on teenagers' perception of control, sense of self, and different levels of social support. Teenagers found the flexibility of participation, anonymity, and choice to selectively disclose during activities in the ARC helpful. However, some teens also felt the reciprocity of interactions between participants on the Slack groups were limited. Our contributions are:

1. Empirical findings on design needs and implications for technologies for stress management for teenagers and
2. Reflections on use of Asynchronous Remote Communities with teenagers to involve them in designing for well-being.

BACKGROUND

Our research draws on previous work on designing for teenagers and on teens' design needs for mental health and social support technologies. Considerations for research with teenagers, particularly in HCI, informed our approach.

Designing for Teenagers

Although designing for teens is similar to designing for adults in many ways, there are still unique aspects of adolescent development for 13–18 year olds that must be considered during the design process. According to Galvan [19], these aspects include: (1) Seeking new experiences or thrills, (2) the part of the brain responsible for understanding consequences is not fully developed, (3) sensitivity to social and emotional situations, and (4) stronger responses to rewards than adults or younger children. Basic design considerations for teenagers include low- or no-cost availability, a clutter-free interface, making the content easy to understand (5–8th grade reading level), and activities and interventions more tailored to teenage life (such as school work, peer conflicts) [20].

In a systematic review of papers in the Interaction Design and Children conference (IDC), researchers found that there was much less emphasis on teenagers than on other age groups [41]. Researchers have experienced challenges when working with adolescents using HCI methods (such as curt or not fully-formed responses, power imbalance, and access constraints) and called for additional methods to engage teenagers [30]. Focus groups can help balance power dynamics between researchers and teens and scaffold peer support [30]. With the pervasiveness of online social networking tools among millennials, there is potential for using online methods to engage with youth in research. For example, researchers enrolled 79 young adults on “secret” Facebook groups to deliver Cognitive Behavioral Therapy (CBT) interventions for quitting smoking across 90 days; at least two thirds of these participants made one or more attempts to quit smoking [37].

Researchers have successfully used the Asynchronous Remote Communities (ARC) method for adults living with chronic and stigmatized illnesses for people who have challenges with access [23, 24]. There are potential benefits to using the ARC method for adolescents, which is one of the research goals of our work in this paper. For teens, ARC on social networking platforms might offer more convenient and lightweight access (e.g., ([11]) than visiting offline research sites, as teens have busy schedules and might need parental support to reach in-person studies [30]. ARC also supports engaging with and following teens' activities over time and with teens who are geographically distributed. Important considerations for using ARC with minors include maintaining privacy and confidentiality, ethical handling of adverse event disclosures online (such as suicidality, abuse, or harassment), and possibility of distress for others in a group setting. These challenges can be addressed through careful planning and moderation. SharpTalk is an online moderated peer support discussion forum designed by Sharkey et al. for 16–25 year old youth who engage in self-harm [34]. Sharkey et al.'s process of negotiating ethical measures includes balancing participant safety and their preference to remain anonymous [34]. We discuss these ethical considerations in the Methods section.

Adolescent Mental Health and Technologies

Technologies can create different modalities of engagement to help teens develop their mental health. Engaging parents and pre-adolescents in digital storytelling with dialogic inquiry [35] and design of a toy that provides real time biofeedback [36] helped children understand and mediate negative emotional responses using Social and Emotional Learning (SEL) skills such as breathing techniques. EMAR, a social robot [32] designed to ask teens about their stress, was designed in Participatory Design sessions with teenagers to support emotive, humanoid, and embodied interactions. Adding gaming elements of fun and metaphors in CBT based strategies during therapy sessions helped adolescents understand difficult concepts of CBT and increased engagement [16].

Designers of health applications that encourage teens to collaborate must consider teens' privacy preferences. Teens preferred to obscure personal health data (such as sleep data) when sharing self-tracking data with family members [29]. Mobile Mood Diary [25] was an application developed for charting teenagers' moods and sharing them with therapists. Adolescents and therapists noted the app should be easy to conceal or be password protected due to the stigma associated with mental health. Additionally, they said such apps must be *"engaging, interactive, provide concise information, be aesthetically attractive, allow for personalization, and provide reminders."* Therapists were concerned about increased responsibility, cost, need for training, and ambiguity of boundaries about when to monitor patients [25]. We designed group activities such as mapping one's social support network, imagining advice for parents, and providing feedback on storyboards, with a focus on examining the boundaries in sharing stress related data with adults.

To understand stress (RQ1), we use Lazarus and Cohen's theoretical lens of viewing stress and stress response as transactions between an individual and their environment [22]. An individual develops coping responses after primary appraisal of the significance of the stressful stimuli and secondary appraisal of perceived control as well as the availability of resources to respond to the stressful stimuli such as social support and time. Depending on their appraisal and feedback (the outcome of their stress response), individuals may develop preferences for different coping styles such as emotional coping (e.g., venting) and/or logistical problem solving. During adolescence, teens usually start encountering unfamiliar stress responses and developing ways to cope. Technologies can support teens with appraisal (e.g., mediate social support, thought analysis (CBT [10])), support reflection on stress response and outcome, enhance feedback, and expose teens to different evidence based options for coping.

Communication Needs for Emotional Support

The pervasiveness of new-age media has led to a shift in the notion of family-time to incorporate digitally-mediated family interactions and contextual rules in families around use of digital media [13]. Teens are not always transparent with their parents about their social media use and online risk experiences [40]. Rapidly changing technologies and use of personal devices make it difficult for parents to keep track of teens' online behaviors and to protect the teens' privacy online [13]. Latina teens wanted to use technologies for emotional support in advocating for their cultural needs against stereotypes, bridging acculturation

gaps between them and their parents, and sharing relevant knowledge, such as college and dating, with parents [38]. Young teens (seventh graders) wanted parents to communicate with their teens on FaceTime in the car (although it is not safe) [12]. During conflicts with parents, these teens wanted technologies to indicate that they want to be heard or given a chance to explain [12]. They suggested using technology as a shield to avoid communicating about emotional states in some contexts with their siblings directly, instead using non-verbal and visual cues through an emotion sensing watch [12]. We incorporated these aspects of technology mediated communication into our storyboards (Appendix C) and diary activities, and discuss a design space for technologies for stress management.

METHODS

Study Procedures

We enrolled 23 teenagers in a private online group on Slack to participate in design activities for 3 months. This study was approved under minimal risk status by our university's Institutional Review Board (IRB). We invited teenagers (13–19 years age) to participate in an 8–10 week online study on designing for stress management. We posted our recruitment blurb on the Reddit group r/teenagers, our university's recruitment site, and researchers' social networks (which then spread via word-of-mouth), distributed flyers to students outside two high schools, and posted flyers around our university campus.

We first directed all interested participants to a screening survey asking gender, age, and preferred platform (Facebook or Slack). We then sent online assent forms along with online group guidelines to all interested teenagers. Due to the remote nature of the study, we obtained emergency contact information of an adult to whom we could reach out during disclosures of physical harm to self or another. Initially, we asked teens under the age of 17 to provide contact information of parents so we could obtain parental permission. We found that some interested teens were unable to participate as their parental contact was not responsive or teens were unwilling to provide contact information of the parent. After consultation with our university's Institutional Review Board (IRB), we obtained a complete waiver of parental permission so that we would not have to exclude these participants. We recruited 9 adolescents before this waiver and 2 adolescents after. We compensated participants every two weeks with \$5 gift cards per week for 20 minutes of activity time.

Fifty eight teens responded to the screening survey and 27 teens consented to participate. We gave each interested teen a choice of whether they wanted to join a Facebook group, a Slack group, and/or other platforms (participants could suggest alternatives). While previous ARC research has leveraged Facebook, we were concerned that its real name policy could create discomfort for participants, place them at risk, or cause them to choose not to participate. Of the teens who consented to participate, 15 teens selected only Slack, 3 teens selected only Facebook, and 9 teens selected both Slack and Facebook. We decided to run a Slack group after asking those who preferred Facebook if they were willing to join a Slack group and they agreed. Three participants did not respond after consent. One teen joined Group 2, but she did not complete any activities. We obtained and analyzed data from 23 teenagers (age 13–19 years) in two online asynchronous private groups on Slack for 3 months. We aimed to keep the group size to 10–15 participants so that participation and group moderation would

not be overwhelming. Depending on timing of recruitment, we split the teens into two groups staggered by 3 weeks: 10 teens in Group 1 (labelled T1-T10) and 13 teens in Group 2 (labelled T11-T23). Participants could exit the study and/or the group at any time. Four participants dropped out from group 2 after week 5 (T21-T23), two participants (T9, T10) dropped out from group 1 after week 4. The first author moderated all groups: posted activities on Slack and sent it to participants on email, responded to participants, and sent reminders to teens who were late in completing activities.

Entry surveys: All participants individually filled out an online survey that included the Perceived Stress Scale (PSS) for the past month [15] to provide context for the initial levels of stress as the teens joined the group.

Activities on private online group: In each group, we asked participants to participate in an activity each week that we estimated took approximately 20 minutes to complete. We posted a total of 10 activities. These activities were related to (1) understanding stressors and stress responses, (2) existing coping styles, tools, and resources for stress management, (3) challenges in support for stress management, (4) feedback from teens on design of technologies for improving support stress-management, and (5) envisioning future tools and support for managing stress and mental health. These activities are detailed in Appendix A and B. In two design-focused activities, teens provided feedback on existing free mobile applications and storyboards illustrating speculated design ideas prepared by researchers (Appendix C). In week 10, teens envisioned their own designs and each teen posted three ideas for support with stress management with or without technologies.

Exit interviews or surveys: All participants (including those who dropped out) were invited to interview with us one-on-one to share their personal experiences in the study and with stress management (interviews lasted 30–60 minutes, compensation \$15). Participants who did not have time for an interview could alternatively respond to a survey (20 minutes, compensation \$10). The interviews were semi-structured and topics included: use and feedback on Slack, experience in the study, stress management, technologies for health, and social support and involvement of family. We conducted 15 interviews and received 5 survey responses (3 participants did not respond). All interviews were transcribed. We then asked all participants to fill out online questionnaires on PSS [15] (same as the entry survey), how helpful or unhelpful each activity was on a scale of 1–5, and demographic information.

Participants

As our study on stress is not specific to a diagnosis, we did not ask participants to report any physical or mental health diagnoses. During the course of the study, 3 teens mentioned challenges with anxiety. The majority of our participants were female (Table 1). Our study is biased towards frequent internet users and their identity as a teenager was based on self-disclosure [26]. We aimed to mitigate this challenge in our recruitment by distributing flyers outside high schools and posting on moderate group for teenagers. We also asked teens to provide school names in the intake survey and some teens used school affiliated emails.

Ethical Considerations

We obtained emergency contact information of an adult from all teen participants and informed the teens that this person would be contacted if they disclose medical emergencies and/or concerns of harm to self or another. With the consent forms, we asked participants to review group guidelines and pinned it on the Slack group (Appendix D). We informed all teens that we are not counselors but are willing to listen to grievances and provided them with 24×7 helpline numbers to reach out to professionals. We had protocols for online disclosures of adverse events (Appendix E) and child abuse (Appendix F) in place for the research team. The first author monitored all posts within 24–48 hours for concerns of safety and emotional distress, and reached out to teens via email or Slack private message. No immediate risks of physical harm or abuse were disclosed during the course of the study.

Data Analysis

We conducted the analysis in two parts, focusing first on teenagers' design needs for stress management and then on the use of the ARC method. The first data-set included participants' responses to design activities, focusing on diary entries, social support map, storyboard feedback, feedback on app activity, and codesign activity. The second data-set included exit interviews, exit survey feedback, and network analysis of interactions on Slack. For both data-sets, we first analyzed the data inductively and then conducted affinity-modelling based on our research questions. The first author read all posts on Slack and interview transcripts, coded a subset of the data, and prepared a code book (Appendix G) by defining codes for all research questions. Two coders inductively coded two interviews, discussed discrepancies in coding till consensus was reached, and iterated on codes. Four coders coded the remaining interviews and design activities, independently, based on the code book, while writing memos. The first author reviewed and discussed all codes and memos with the research team to iterate on themes.

To visualize and better understand interactions between participants on the group, we conducted a network analysis after collecting the data using Slack API. We used Gephi [9] to create the network graph by defining participants as nodes and interactions between participants as edges. We assigned weights to participant replies (1 point) and reactions¹ (0.5 points) on Slack, which mapped to the thickness of the edges (Appendix A). We also calculated the frequency of interactions between teens for each activity (excluding interactions with the researcher, Appendix A).

DESIGN NEEDS OF TEENAGERS

Three major themes emerged from our analysis of support that teenagers envision technologies providing for stress management: (1) meeting teens at their perception of control, (2) designing for the developing sense of self in teenagers, and (3) scaffolding varying levels of social support. These design needs reflected both a desire for self-management and seeking social support, with the former being more prominent. We explain

¹Slack users can add reactions to Slack posts with one or more emojis, such as a thumbs up or a smile.

each theme with the underlying needs expressed by teens, perceived opportunities for technologies, and designs envisioned by teens to support their needs.

Meeting Teenagers at their Perception of Control

Participants scored an average of 21 on the Perceived Stress Scale (PSS, score range 0–40) (std dev.=5.8, n=23) and average of 20.2 on the exit PSS (std dev. =6.1, n=21). Scores of 20 and above are considered moderate to high stress [15]. Teens reported their sources of stress including school (n=20), thinking about the future (n=17), friends (n=13), family (n=12), and health (n=10). Participants perceived stress as overpowering, as depicted in the drawings they created to share what stress looks like to them (Figure 1).

Healthy coping was very individual for teenagers. Teens shared coping strategies that helped them regain a sense of control or reduce feeling overwhelmed by stress. These coping strategies included venting, meticulous planning and time management, and switching contexts before tackling stressful tasks. T2 explained that venting to others was helpful, “*I have found myself using 7 Cups [online therapy tool] so often, and, having someone listen to me really helps me calm down.*” T6 and T7 wanted a platform for venting in their codesign. T1 said she usually uses an alternate or fake Instagram private account (“*finstagram*”) for venting. She explained that in these posts, she felt annoyed by suggestions or positive reframing of the situation from others.

For reminders, teens used both calendars and paper and digital planners. To increase their sense of control over the stressful task at hand, and not avoid it until when it is critical, teens suggested designs that help them reduce the perception of the magnitude of the task to an amount they would feel comfortable starting with and getting done. For example, T4 envisioned a planning tool that helped them break down their tasks and distribute it on their calendar automatically,

My third idea is a sort of add-on app to your calendar that gives you mini goals based on what it sees coming up in your calendar. For example, if I had a research paper due in a week’s time, it would give me mini goals based on those parameters and on days where it shows that you don’t have much activity. So, if it were to see that I didn’t log anything for February the 8th in my calendar, it would send me a reminder that day to write my outline, and the next time there’s a blank space before the due date, a note to write my intro/first body paragraph. I feel it would probably be helpful to students who have trouble with procrastination, since mini specific goals, always make it easier for you to know where to start.

Teens valued support from technologies to help switch contexts and relax. While distraction may be considered a waste of time in their busy schedule, teens praised existing applications that helped them relieve their stress by taking a break. Some teens described taking a break and switching context to be helpful for gaining a different perspective when they come back to the activity from which they took a break. T4 explained, “*Sometimes when I’m feeling rather stressed I just pop on over to Netflix and watch a couple of my favourite episodes from old telly dramas I’ve finished. They sometimes get me thinking about other aspects in my life besides the issue I’m skirting about, and by the end of it all, I might feel a bit more ready to tackle the issue at hand.*”

Teens also valued doing activities they teens enjoyed or found relaxing, such as listening to music, alongside other stressful activities. T7 shared an image of a water bottle as a tool that helps her manage stress. She explained, *“My water bottle always makes me feel more relaxed. Maybe it’s because I feel like I know I’m being healthier, or maybe it’s because it’s something to keep my body busy while I think.”* T1 used a color matching game app, *I Love Hue* [4], explaining, *“I often play it at school or while watching TV at home because it’s so satisfying and calm; it has no time limit and it feels really good to put things back in order, especially because I like organization a lot.”* Teens who tried apps for mindfulness (e.g., *Headspace* [3]) and videos on YouTube that directly target relaxation skills during the app activity also found it helpful. T16 praised *Headspace*, stating, *“I really enjoyed the app because it gave me a mini escape from the real world and it did help me calm down.”* T12 said, *“I want to keep using this app [Headspace] because it really helped calm me down and reduce my stress.”* T3 said, *“If the app were to expand, and offer its own stress management techniques, like meditation, it could definitely stand-alone (maybe with a connection to a Fitbit or something that could detect higher heart rates from stress.”* Enjoying meaningful breaks or moments away from technologies but prompted by technologies was also sought for by some teens. T14 stated that the app *Happify* [2] helped distract her, which provided her relief and got her *“inspired to take a break and watch the sunset.”*

Empowering Teenagers’ Developing Sense of Self

All participants wanted to manage stress by themselves. They emphasized that each teenager has individual needs and preferences, thus, developing a distinct sense of self. To that end, they recommended personalized interventions that are based on these individual preferences and that support self-reflection. In the values activity, 15 teens prioritized autonomy as an important value. To cater to the values of seeking autonomy and wanting to take ownership of their teenager experience and health, we designed a low fidelity storyboard for an app design called *Teens Advice* (Appendix C: Storyboard 7) which would be created by teens with advice for other teens and parents on mental health. We presented it to participants in Group 2, all of whom appreciated it. They also had ideas for further customizing the app. For instance, T14 and T17 said there is no general solution that will work for all teens. To address this, four teens (T13, T15, T16, T18) suggested categorizing the content presented in the app design (in the form of quizzes, activities, or advice) to account for differences, which can provide faster, more relevant information. T18 suggested,

There could be categories too like: ‘Dating & Romance’, ‘Hygiene & health’, ‘Family’, ‘LGBTQ’, ‘School’, ‘Social Life’, ‘Mental Disorders’ etc. These topics can branch off, like, ‘Hygiene & Health’ – ‘Sleep’, ‘Menstrual Periods’, ‘Birth Control’, and then ‘Mental Disorders’ – ‘Learning Disorders’, ‘Self-Harm’, ‘Eating Disorders’, ‘Anxieties’, ‘Mood Disorder.’

Their ideas also included systemic integration to support mental health in schools and at a societal level through popular media, such as promoting mental health awareness by creating YouTube videos. T7 brainstormed a curriculum on emotional and mental wellbeing that she envisioned teaching in schools, *“Starting from a younger age, discussing feelings, bodies, how to communicate, how to listen, how to problem-solve, as well as topics like racism, sexism, mental health, how to stay safe on the internet, and even harder topics like abuse,*

divorce, and other stuff I can't remember. That curriculum, as I've pictured in my dreams or something like that, would start as early as kindergarten, and continue through elementary school."

Throughout the study, teens emphasized that every teen is different: what may work for some may not work for others. Several teens called for personalized experiences where teens can try out different activities as per their interests and rate how much each helped them. T1 stated, *"I like apps that can 'get to know you' and suggest things following what you like."* T16 envisioned personalizing objects that help relieve stress,

A website that creates a personalized 'stress box.' A stress box would be a box of things (or even a list of reminders) or really anything that may help you when you are stressed. Examples can include your favorite baby blanket, a chocolate bar, a letter to yourself, etc.. A personalized stress box would require a couple of questions that outline common sources of your stress and suggest items to put in your stress box.

Furthermore, T12 and T6 said some solutions are not suited for teens of all ages. Critiquing the storyboard of an application to share schedule with parents, T12 said, *"this is probably better for freshmen and younger because it lets student be a little more independent but still rely on their parents' influence."*

Three teens (T1, T14, T19) envisioned technologies that prompt recall and reflection to see growth over time. They suggested that technologies could scaffold this growth by reminding them to reflect on positive aspects. T1 suggested, *"a simple app with prompts every day that you go through again each year and can get notifications to remind you to answer your print of the day."* T14 stated, *"it can be nice to write down anything that made you happy – to remind you of those times when things aren't going quite as great."* In these proposed solutions, teens hoped to use technology to reflect on their past to help them manage their current experiences.

T10 found writing a letter to stress (a prompt on the diary activity) very helpful. She started her letter by venting and progressed towards positive reflection,

I keep forgetting it is in MY power to get rid of you [stress] and that any day I can start, but ever day it is so easy to give up. So much EASIER to give up. But if it was easy everyone would do it. If it was easy, I would not feel good about doing it. So I will face the hard, I will face it head on until there is no bad habits of you. I cannot get better unless its hard because that's not getting better that's just hiding my stress and pushing it away. So today will be the first day i will face you head on, and not give in to your words. This is so special to me.

Teens explained that technologies may not only increase communication during stressful situations but also help communication by creating space between teens and their parents to work through issues. T8 said, *"Sometimes people need space. And I think this app [design idea that calls for time-out in communication] can help with that."* T5 said that space is not always a good thing when it comes to communicating, stating, *"If my mom keeps pushing off talking to me I'll just feel worse."*

Scaffolding Varying Levels of Social Support

Teens expressed that their social needs change based on their situation and characteristics of the individual(s) to whom they have access. Many teens supported collaborating with their parents but with certain concerns, seeking to establish boundaries. Teens perceived that parents may face issues in being able to reach out to the teen, effectively (*“break(ing) the shell their child may have created”* (T15)), not having all information about a situation, or not knowing their teen well enough. T13 added that parents might have to recognize that they themselves can sometimes be a source of stress for their teens.

Teens expressed the need to receive proactive support from parents. Seven teens (T11, T12-T14, T16-T18) expressed that it is the parents’ responsibility to learn about the issues and coping strategies relevant to teens. They suggested that technology can provide parents with crowd-sourced resources and tips for communicating with their teens. T6 explained,

It’s important for parents to understand the many causes of teen stress other than school and work, such as relationships, the future, and even personal identity. They also need to understand what helps teens relax, like friends, enjoyable extracurriculars, or watching TV. Knowing that stress is existent in all areas of teen life will prevent parents from just focusing on how much their teen studies or sleeps. Similarly, knowing the ways teens relax will hopefully stop parents from trying to control their kids and say “you should be studying, not watching TV” and “don’t hang out with friends;” saying these things pushes kids towards stress and away from activities that benefit their health.

Several teens (T2, T8, T11, T13, T17, T18) expressed concern that their parents’ interventions tried to take control away from the teens which teens did not find helpful. On the storyboard that suggested sharing their schedule with parents, T13 said, *“It would really frustrate me to feel this micromanaged by an adult, I really like having my space and this would feel like I was being controlled.”* Two teens also discussed how relying on technology to interface with families can lead to unhealthy dependence on families for teens (T11) and that an application might be unnecessary to mediate interactions with family (T16). Four teens (T14, T15, T17, T18) wished that parents would help teens with ways to relieve stress and support their teens without inquiry. T18 stated that it is important to do so without being *“intrusive”*, *“Parents should ask ‘is there anything I can help you with?’ And do it in a way that isn’t intrusive. I find that when I ask for help and my parents don’t question me, I feel like they’re trusting me and just trying to help. Not seeing me reaching out to them as an opportunity for them [to] scope out my life.”*

T3 and T8 also provided some insight into balancing the level of family involvement in which the family is aware of the situation but not driving the teen’s actions. T8 said, *“I think it’s a good way for parents to be involved without being too heavily involved.”* Teens supported technological solutions that helped them negotiate their priorities with their parents. T16 pointed out that a solution that mediates arguments is helpful because *“when people are arguing they often interrupt each other.”* Having a third party stop any escalation might be helpful. T18, however, raised an important point that all parties must buy-into the

idea of compromise and that parents and teens are not always as willing to come to a compromise as this type of solution would require.

Though five teens appreciated using memes with peers in the introduction activity as an ice-breaker, six teens rejected the idea of using memes or other trends as a way for parents to connect with their teens due to it being generationally inappropriate. T1 said, *“It’s trying to relate to our generation but ends up being something we totally make fun of.”* T19 said, *“I never really share memes with my parents (my sense of humour does not line up with theirs). I figure finding a way to break the ice on a hard conversation is awesome, but memes aren’t really the right way to do that.”* A few teens supported the idea of collaborative reflection with parents. T14 points out that communication highlighting positive aspects in a day can elicit appreciation for each other: *“A parent and teen could keep a log of things that they really appreciate or didn’t like too much that the other person did. At the end of each day, they should discuss what they have written down.”*

Six teens wanted communication channels outside family to help manage their stress. T6, T7, T15 and T14 ideated on a venting channel or a *“messaging service where you get linked with a person who’s also experiencing stress (or maybe to a professional who can help you manage stress).”* Their preferences for anonymity varied but they wanted to connect by sharing similar experiences. T16 shared the idea of having a *“pen pal (someone in the same grade, age or region as you)”* with whom she could vent in writing. T8, however, emphasized that a system or other user must provide a fast response: *“I’ve had to wait an upward of half an hour for someone to reply to me, making me not want to try it again. But if you could get a speedy reply, I think that would be really useful.”* T11 suggested scaffolding support from loved ones, *“Stress management: an app that list some activities that could help manage stress. It would have a feature to link someone you love to remind you to do the things.”*

Teens appreciated seamless social support when other people helped them unexpectedly, as *“a nice surprise”* (T14) and that getting help without asking for it *“would be an ideal situation”* (T11). Participants said that reciprocating help can benefit both teens and their community. Technology can scaffold these interactions explicitly or implicitly. T14 explained her experience on an online community on *Happify*: *“I made a pledge to do something nice for someone and sent a compliment to one of the people that is most important to me. It felt good to take a minute to do something nice instead of always being so caught up in my own problems.”*

ARC METHOD FOR ENGAGING TEENAGERS

Using the ARC method supported: (1) Flexibility in participation due to the asynchronous nature of the study, (2) Technology mediated selective disclosure, and (3) Reciprocity and interactions among group members. In addition to the positives of the asynchronous method, we asked teens about potential difficulties and benefits of face-to-face alternate method. Their responses included: (1) logistical difficulties of scheduling face to face study sessions, (2) emotional difficulties in sharing in face to face settings, and (3) potential of a face-to-face setting to foster human connection, collaboration, and empathy compared to the online

method. We explain our findings on the advantages and disadvantages of the ARC method and comparisons with face-to-face methods as perceived by teens.

Flexibility in Asynchronous Participation

Most teens appreciated having short 20 minute activities each week. Nine teens stated that the study design allowed for flexibility in when they could do study tasks. Many of these teens had obligations such as school work, jobs, and family commitments. Amidst these responsibilities, these teens did not perceive the addition of weekly study activities as an additional stressor. We designed 8 of the 10 activities so they could be completed any time within the week; teens valued being able to complete study activities during the time of the week that best fit their schedule. Most participants found the activities did not take too long to complete; they appreciated that this low time commitment did not hinder other activities during the day or week. T8 said, *“To me, that [completing activities] was just time management. I knew I had to get it done before Monday, for example. So, I’d plan it out in my week. Okay, maybe Wednesday night is when I’ll get this done.”* T4 explained, *“If I had a lot of stuff to do, I would either get it done early, or do it at the very end. So that wasn’t a huge problem for me.”*

In two other activities, teens were required to enter four diary entries on at least four separate days in a week. Though the teens found diary activities helpful for self-reflection, three teens (T3, T15, T16) mentioned that it was difficult to remember to complete and keep track of the diary every day. T16 found it hard to keep up with the diary activities because she said it was more commitment for them. For the teens who did not complete the diary activities regularly, we sent them an additional link with multiple of these activities after the deadline allowing the teens to complete them in one go. T15 explained her challenge, *“There were a couple activities that required us to submit a sheet four times in a week and that was a little hard for me because sometimes I would forget. At the end of the week I’d remember that ‘oh, I forgot to turn it in’ and I could only do one sheet per day. I liked that on the other activities that I was able to just do it all in one shot. That was just one problem I had – but other than that, the ones on Slack were really straightforward and easy to complete.”* T3 said he did not write much in the diaries because it felt he was saying the same thing every day. T3 was aware that the researcher was going to read them and he thought too much redundancy might bore the researcher.

Two teens (T4, T14) explained that the asynchronous study design gave them more time to think about their responses to more complex questions. They speculated that in a face-to-face study, they would need to come up with responses on the fly, which they said would likely have led to poorer quality responses. T14 said, *“Because sometimes you [researcher] ask a kind of complex question, or you ask someone to come up with a unique idea, it might take a little bit longer. I think that would feel a little bit rushed if you’re doing it in-person.”*

Participants T4, T8, T16, and T17 said that finding a time that works for everyone for a face-to-face group study and committing to that time over a long period would be particularly challenging. T17 said, *“It’s definitely gonna be harder for someone to come over to the lab because [each activity] is not that long each time. It’s like 20 minutes. I feel like most of the people wouldn’t have that much time to just go to the lab every weekend and meet with your*

guys.” As researchers, we found it advantageous to engage in activities with teens over the course of 10 weeks. Some questions from these activities could have been asked in a single interview, but not all (e.g., diary entry, app feedback). Particularly, the activity on introducing teens to an app in Week 7 and obtaining their feedback gave us the chance to follow up on the use of these apps after 2–3 weeks during the exit interview. We also gained an understanding of their challenges and time constraints as they worked through different stressful situations over time such as relationship issues, family commitments, mid-terms, and finals. The teens also appreciated having time to think about ideas before posting them.

Technology Mediated Disclosure

Eight interviewees mentioned that sharing their personal stories about stress with people in the group was comfortable for them. T4 and T1 perceived that sharing personal stories with ARC participants would not affect the readers emotionally as the readers could not put a face to the name on Slack. T8 mentioned that sharing was comfortable because she did not see these participants every day like she sees her friends. She explained that her friends reminded her of stressors and, in turn, stressed her out consistently (which she says is like a “*stress loop*”). All in all, lack of familiarity and the sense of “*not knowing*” the other person and staying anonymous helped the teens to feel more comfortable sharing stress-related information. T4 said, “*They don’t know you yet, so what you say won’t really, I don’t know, [affect] them in any way.*” T8 explained, “*I don’t wanna say with strangers, but with people who I just don’t see everyday because sometimes if you share things with your close friends for example, they might bring up your problems with you and you might not want to be reminded of that.*” T16 said, “*It’s very sensitive information that is better shared behind the screen names than face to face.*”

In contrast, two teens (T13 and T16) felt reserved about sharing certain personal experiences in the online group format. T13 struggled with balancing her anonymity, group members’ anonymity, and sharing personal and sensitive information. She explained, “*That’s kind of a tricky balance between like being anonymous, but also you don’t know who you’re talking to and so it can be a little bit nerve-wracking to disclose stuff.*”

In two weeks of activities (Appendix B: weeks 5 and 8), we asked teens to complete diary entries redirecting them to a private online survey. Three teens (T1, T2, and T16) liked doing the diary activities because it allowed more privacy than in the group to write about personal thoughts. T1 and T2 thought that the open ended prompts in the diary allowed more freedom for them to write what was on their mind without worrying about sounding professional, unlike in a post for the group activities. T16, however, reflected on difficulty with sharing on the private diary prompts as well, “*I feel like personal experiences, I think it was the stress diary about times when I had conflicts with people, like relationships with my family or my friends, that was a little harder to share. Because I don’t usually talk about that stuff.*”

Seven participants stated that meeting people they do not know and sharing personal stories about stress in real life face-to-face setting adds a layer of discomfort. Some of these participants mentioned that talking about mental illness or stress would be difficult in a face-to-face setting due to stigma. These teens said that they felt more comfortable sharing personal anecdotes using a technology tool that supports anonymity, whereas a face-to-face

environment diminishes anonymity. T8 said, *“I think, maybe it would be harder to talk about some of the things that make us stressed. I know, like when you post things online and you’re anonymous under a different name, maybe you feel like it’s easier to share things that you really wouldn’t have shared before.”* T4 speculated, *“I would probably be a bit more shy at first, because it’s easier to type something into your computer, but it’s a bit harder to talk to other people when you don’t really know them yet.”*

Reciprocity and Interactions Among Group Members

Our network analysis (Appendix A) shows that there were 263 total interactions (replies and responses) including the researcher and 51 (19.4%) interactions between the teens in Group 1. In Group 2, interactions between the teens accounted for 47 (16.4%) of 286 total interactions. Activities that had the highest frequency of teen interactions were the advice column and codesign. In these two activities, we explicitly asked participants to interact with each other and allotted time for feedback in the study task (5 minutes). While some teens rarely interacted with other participants (e.g., T5, T16, T20), teens such as T1, T2, T6, T7, T18 and T19 were usually more proactive about responding and had more frequent interactions than others. T7 and T18 catalyzed feedback during the storyboard and codesign activities.

Collaborative sharing of ideas in a group setting can allow teens to develop their thoughts in the design ideation processes. Three interviewees (T4, T3, and T8) stated that sharing ideas in the online group was useful. T4 and T8 specifically mentioned that the ability to read other participant responses provided utility because it allowed them to initiate their own design ideas. T3 also stated that the degree of openness from others in the group helped her feel more comfortable sharing, *“Other people were a little more open; and that helped me open up because I just wanted to know the degree of transparency that was being used in the study.”* Most teens said that reading others’ posts influenced their own posts. T1 read others’ posts to get a better idea of what the prompt was asking when she was confused. T14 and T16 read people’s responses when they were unsure how to respond to some activities. Likewise, T4 said, *“When we were coming up with designs for stress tools toward the end, I wasn’t sure what ideas to come up with so I kind of read over some of the other people’s ideas and then it was able to inspire me to come up with my own ideas as well.”* T3 said reading others’ responses made him change some of his own responses. However, T2, purposefully avoided reading others’ posts before posting just so her post would not be influenced by what others say.

Most teens expressed that there were fewer interactions between teens in the group than they expected. When asked how to encourage more group conversations online, T6, who would have liked more interactions, suggested ideas to match buddies at the start of the study which might help increase reciprocity in the group. She brainstormed, *“In this group, nobody knew each other, so it was all strangers. There were no parent interactions. I would like to say, assign a buddy or someone to start volunteering then I would be willing to buddy somebody and then maybe match them up or something.”* T14 suggested compromising flexibility of participation for a few activities by having everyone everyone on the study online and working on an activity at the same time. She provided an example, *“Sundays*

from 1:00 to 2:00, you have to do your studies.” But ultimately, she was unsure if it would be worth it to have everyone go on at the same time, especially as different teens are in different timezones. A few teens also said they did not prefer more interactions than in this study.

Our codesign prompt was open-ended and the teens were not required to converge on design ideas. T1 speculated that having a face-to-face study and working together would facilitate coming up with more cohesive ideas and building off of peers’ ideas. She said, *“In an actual face-to-face discussion it would have been easier to build off each other. I feel like we would have come up with more cohesive ideas rather than all having an idea and maybe a couple of people respond. If you’re working on a group project in school, and you’re all working together at the same time instead of all coming up with these separate things kind of all at the same time.”* Three participants (T13, T8, and T1) mentioned that doing this study in-person could foster reciprocal interactions among group members. Even though these participants liked the flexibility of the ARC, they acknowledged that meeting other participants in-person would help foster empathy and people could put in more effort in the conversations and interactions.

No teen said they had any negative experiences in the online groups. T16 expressed that her experience was “pretty neutral” and T21 did not find the study useful to herself (she dropped out in week 4). All other participants described having positive experiences with the group. For example, T1 liked it when participants tagged her in their responses and agreed with her posts. T2 liked reading other people’s posts and seeing that they had gone through similar experiences. She said, *“I’ve been able to relate to other people in the study, reading their posts and seeing that they’ve gone through the same things and felt the same things. It’s been very therapeutic.”* T3 and T14 felt that everyone was supportive and nice. T4 reminisced that they received unexpected positive comments for some of their drawings which contributed to a supportive feeling.

DISCUSSION

Design Needs for Teen Stress Management

Technology has the potential to help teens learn and practice healthy responses to the experience of stress. Technologies could be designed to help tailor interventions depending on the perception of control of teens, to empower teens to learn, share, to teach teens to rely on themselves for managing stress, and to mediate social support. The teens’ perceived locus of control of stressors on external factors confirms similar findings in physical health [12]. Providing logistical and emotional support, such as planning and a platform to through which to vent, can support them to shift this locus of control to themselves. Teens in our study recognized that providing a platform and prompts for self-reflection through technologies can help with their individual growth. Similar to teens in this study, Vacca et al. found that Latina teens wanted a tool for venting and journaling – “tink tink”, in which they could post a rant anonymously or save it to support private self-reflection [38]. Evidence-based strategies in positive psychology, such as sharing 3 Good Things or gratitude, may be other ways to improve teens’ optimistic perceptions of response to stressors [33].

In their real life social networks, teens get different types of support from peers and adults [39]. How they prefer to interact with adults may differ based on age, cultural relevance, topic, perceived stigma, and levels of trust. For example, sharing memes with parents was not seen favorably in our study, whereas Latina teens ideated “MomChill” [38], wherein they could share memes with their mom to share about teen norms on relationships. Social support on stress in adolescence could also be provided solely through technologies such as venting to a robot, EMAR [32], which responded to them with social cues. Though robots can be difficult to access, similar experiences exist online using chatbots (Woebot [6, 18], 7 cups of tea [7]) or virtual assistants.

Designers should balance perceptions of teens to support engagement and recommendations from evidence-based practices. Perceived approaches that teens think may help, may not line up with evidence-based methods for reducing stress. In Table 2, we summarize a design space on technologies for stress management for teenagers based on the three types of support identified in our findings – logistical (e.g., planning and organizing), emotional (e.g., venting and positive restructuring), and informational support.

Reflection on ARC Method

We adapted the ARC method from Facebook [24] to Slack as participants chose anonymity on Slack allowing for choice and comfort in disclosure online (similar to patterns of disclosures on mental health (e.g., [17, 21]). While limited reciprocal interactions in the groups may reflect the teens’ preferences, researchers can brainstorm ways to encourage interactions. Participants interacted in the activities in which we allocated time for and required feedback within the 20 minutes. As we were conducting such a study for the first time with teens, we were very cautious about potential confidentiality and privacy issues in the group guidelines. We did not encourage or discourage the teens to chat with each other outside the group activities (such as in private chat), which might be considered in future work. There were no off-topic conversations in the groups other than the first week of ice-breaker activities. Researchers may try more elaborate ice-breaker activities in the beginning where teens can get to know each other.

Researchers may organize optional online social activities or maintain a separate channel, such as #random, where teens may get to know each other outside the study activities [42]. Assigning “buddies” (T6) each week to check in on one another or work on in pairs, while balancing the burden on their time and privacy, can also be explored. The teens in our study were from different time zones and had busy schedules. Most activity on the group was during evenings (after school hours). Participants felt that some degree of synchronous interaction would have facilitated collaboration, such as during brainstorming. Researchers could explore the potential to involve teens using audio or video conferencing tools such as Google Hangouts, though we note the potential trade offs in flexible scheduling and anonymity. These interactions might be organized as “office hours” where the moderator might set a time and see who is able to show up. Moderators also can model active tagging, encouragement of reactions, and consider explicitly including interactions as a part of the activities.

When using a platform new to most participants, such as Slack, researchers might design early activities to encourage participants to explore different platform features. On Slack, this might include tasks such as reacting to a post, adding images (as in our week 1 activity), tagging others, and using threads (which some teens found confusing). Most participants preferred writing over drawing in the diary or co-design activities. Therefore, having the option of different modalities for presenting an idea or completing an activity was helpful. Teens appreciated that the activities could be completed within 20 minutes and that they had a full week to complete them. Similar to prior ARC studies [23], teens reported liking the structure in which new activities were posted on each Tuesday. However, unlike on Facebook, it was difficult to maintain threads for each activity on Slack. The moderator waited on participants to complete earlier activities thus, delayed posting some activities. We used email and Slack to notify about a new activity and send reminders. Teens found it helpful to keep track of activities and sent us late or private responses to activities via email.

Most teens did not report having an issue with the 3 month duration of the study, and we found it helpful to learn about their challenges and development of ideas over time. We provided extensions in completing activities during finals week and vacations which were different for different schools. Researchers should plan on tailoring the study timeline around travel and hectic weeks beforehand, for example, setting activities relevant to exams or break. We encouraged teens to post 3 good things during breaks (optional) and had no activities during Thanksgiving and Christmas holiday weeks. We timed diary activities on the week after holidays, which prompted reflection on transitioning from break to school and/or spending time with family. Other ideas for increasing engagement might be to use videography [30] to collect and share snapshots from teens' lives instead of text-based diaries. More methods to engage teens may increase the number of teens who may participate in IDC research [41].

CONCLUSION

In this study, we conducted weekly design activities in two online groups on Slack with 23 teenagers over the course of 3 months. Informed by our understanding of design needs envisioned by teenagers on stress management (RQ1), we presented a design space on how might technologies support needs of teenagers for stress management (RQ2). We demonstrated the potential benefits and challenges in using the ARC method with teenagers (RQ3), which we hope will enable researchers to invite and sustain participation from teenagers. Our participants are skewed towards majority female and online users and the findings of our study are primarily based on perceptions of teenagers. In future work, researchers can involve other stakeholders who may support social lives of teenagers such as parents, teachers, and service providers. Researchers can also design ARCs to understand how evidence based support on mental health can be provided to teens for self management and/or in collaboration with stakeholders in their support network.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CCS Concepts

- Human Centered Computing → Human Computer Interaction (HCI);

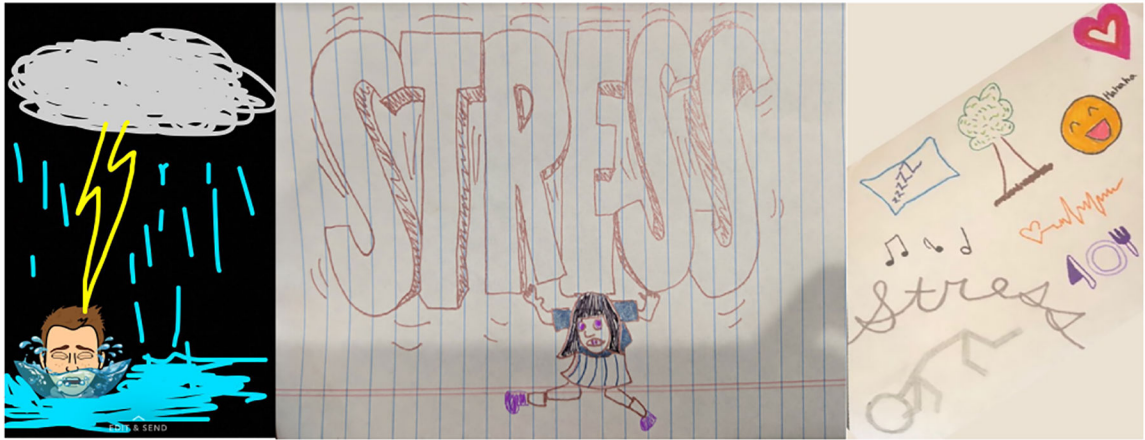


Figure 1.

Teenagers drew what stress looks like to them: a person drowning in water in a thunderstorm (T3), a girl physically being crushed under the weight of stress (T16), “*good things in life that stress cuts you off from*” (e.g., sleep, normal eating habits, laughter, and music) (T14)

Table 1.

Demographic distribution of survey participants (N=23). NR indicates “No Response”.

Gender	Female (19), Male (3), Non-binary (1)
Age	13–17 years (11), 18–19 years (12)
Race	White: 11, Asian: 4, Mixed race: 4, NR: 4 Hispanic (3), Non-Hispanic (16), NR (4)
Region	Sub-urban (10), Urban (7), Rural (3), NR (3)
State	WA (14), CA (2), IA(1), NJ (2), PA (1), WI (1)
HH Income (USD)	<20k (3), 35k to 50k (1), 50k to 75k (1), 75k to 100k (1), 100k to 150k (1), 150k to 200k (3), 200k or more (4), NR (9)
School Type	Public High School (8), Public University or College (6), Private High School (4), Public Online School (1), Private University or College (1), NR (3)

Table 2.

Design space for technology-based stress management for teenagers, including suggestions from participants (indicated with (T)), examples from prior research, and products/services on the market.

Design Needs	Logistical Support	Emotional Support	Informational Support
Tailoring to perception of control	Mini goals (T), Calendar or planner apps	Screamer [38], Headspace [3]	Pacifica [5] (thinking errors, CBT [10])
Empowering sense of self	Help teens organize content on mental health (T)	Happify [2], 3 Good Things [33, 28]	Pacifica [5], Daylio [1]
Scaffolding social support	Sharing activities to manage stress with loved ones who can send reminders (T), Collaborative goal planning with trusted adults (T)	EMAR [32], Woebot [6, 18], Koko [14, 27], tinktink [38], Galaxy Watch [12], 7 cups of Tea [7]	Helping parents with information to communicate with teens and vice versa (T), Videos for mental health awareness (T)