Wellbeing skills strengthening as a model for healthy adolescent digital technology use

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Digital technologies (DTs) have become ubiquitous. Adolescents are avid users of DTs. As access to and use of DTs has increased among adolescents, daily life and adolescent social interaction patterns have shifted in profound ways. Although the causal relationship between DT use and adolescent wellbeing is not clear, it is clear that the economy driving DT innovation is not designed to promote adolescent wellbeing. Yet, DTs possess characteristics that make them promising avenues for wellbeing promotion because of their accessibility, ability to scale up, and the potential for personalization. In this essay, we propose that strengthening adolescent wellbeing skills through DT interventions may provide the necessary conditions for adaptive adolescent DT use at a public health scale, leading to improved adolescent wellbeing.

Key words: Adolescent; Digital technologies; Social media; Wellbeing; Mental health; Mobile health; Personalization

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Researchers and policy-makers have posited that digital technologies (DTs) such as smartphone apps, websites and social media may be powerful allies in improving mental health and wellbeing.[1] Browser extensions can be built as health promoting interventions. Smartphone apps carry low marginal costs and incredible potential for scale. As interventions scale-up, it may be possible through artificial intelligence (AI) to accurately predict who will benefit most from which intervention (i.e., personalization), and optimize intervention efficacy based on individual characteristics, use patterns, or early treatment responses. Integrated with personal sensing technologies such as wearables, soon AI may be harnessed to generate adaptive wellbeing interventions that are responsive to real-time needs.

In an era when the demand for mental health care providers far outstrips capacity,[2] DTs can help improve access to effective interventions. This promise has not yet been realized, however. Today more than 95% of American adolescents have access to a smartphone.[3] More than 97% of American 13-17 year old adolescents have one or more social media accounts.[4] Internet connectivity is freely available in many public spaces such as schools and libraries. Yet DT saturation has not led to improved adolescent wellbeing at the population-level[5,6] and may be associated with deteriorating adolescent wellbeing in many places in the world.[7]

Research on the relationships between DT use and adolescent wellbeing is complex and sometimes contradictory. This is because the effects of DTs likely vary according to numerous factors, including the type of DT, the content adolescents interact with, DT use and motivation patterns, and also by demographic or other adolescent characteristics.[8–11] The most widely studied metrics of DT use like time on screen do not capture this complexity.[9] Additionally, DT impacts on wellbeing may differ based on the way researchers define wellbeing.

In this essay, we define wellbeing according to a recent training-based operationalization that identifies four primary wellbeing skill domains: awareness (e.g., attention regulation, mindfulness), connection (e.g., strong social connections, prosocial orientations), insight (i.e., self-understanding), and purpose (i.e., finding value and meaning in daily life).[12] Based on the principles of this wellbeing framework, we propose that strengthening adolescent wellbeing skills will not only promote adolescent wellbeing but may also provide the necessary conditions for healthy adolescent DT use. We highlight the potential for DT-based wellbeing trainings to contribute to adolescent wellbeing and to reduce maladaptive DT use patterns.

Growing up in a Different World

DTs have rapidly evolved over the last two decades as they have become ubiquitous, fundamentally shifting the types of information consumed and the ways information is accessed. For instance, newspaper subscriptions have fallen 66% over the last three decades – *inclusive* of digital subscriptions.[13] Where do adolescents today turn for information? Twelve-to-19 year olds are as likely to rely on social media influencers as a primary information source as credentialed news agencies,[14] but only 44% of adolescents are confident in their ability to discern real from fake news.[15]

The social lives of adolescents have been similarly affected. In 2002, adolescents across the globe reported around four hours of screen per day, about 70% of which was tv viewing. By 2010, average daily screen time had increased by more than 2 hours, with about 60% accounted for by computer use.[16] Adolescence is now saturated in DTs. On average, American adolescents report around 7 hours per day on screens.[17,18] American adolescents spend an average of nearly 5 hours per day on social media alone.[19]

As adolescents' time on DTs has increased the time they report socializing in-person has

decreased.[20] Texting is now the most common form of communication, surpassing in-person communication.[21] We do not yet fully understand how these changes to social life and information ecosystems are affecting adolescent development, but we do know that adolescents are biologically primed to allocate heightened salience to social cues while self-regulation skills and risk perception lag behind in development.[22,23] Moreover, brain development during adolescence reflects experience-dependent plasticity. That is, the thoughts, emotions, social contexts, and exposures (e.g., nicotine, poverty, social media) experienced during adolescence contribute to structural and functional brain development, and behaviors, establishing neurobehavioral patterns that will persist throughout adulthood.[24] Adolescence is therefore a period of enhanced risk, but also opportunity;[25] should the increased plasticity that defines this development period be harnessed toward wellbeing promoting patterns of thought and behavior.[26,27]

The Nature of Digital Technologies

Despite significant and legitimate public concerns about the deleterious effects of DTs,[28–31] they are not inherently good or bad. Extant data on the harms of DTs is primarily correlational.[5,8,32] For instance, epidemiological studies have reported correlations between the widespread adoption of social media and declining adolescent health, particularly among females, in many areas of the world.[33,34]

Causal evidence related to DTs exists, but rather than evidence for harm, it suggests reducing DT use may cause benefits. For example, Lambert and colleagues[35] randomly assigned 154 adult participants to either eliminate social media (e.g., Facebook, SnapChat, Tiktok) use for one week or continue using it as usual. Participants assigned to a social media diet reported higher wellbeing, lower anxiety and lower depression scores one week later [35]. In a randomized

controlled trial (RCT) of 220 distressed late adolescents and young adults, restricting social media use to one-hour a day (measured through phone tracking software) significantly reduced anxiety and depressive symptoms while increasing sleep quantity; appearance and weight esteem also improved compared to the unrestricted social media use group.[36,37] In a RCT of 331 adults in which the phones of treatment arm participant were prevented from accessing the internet for two weeks, participants reported significantly improved wellbeing and daily mood (assessed through experience sampling), and improved sustained attention on a cognitive-behavioral task. Increased self-control, social connection, sleep and reduced media consumption mediated improvements in mental health and wellbeing.[38]

There is an emerging consensus that the way DTs are used shape their impacts on wellbeing. It seems to be particularly important whether DT use is deliberate or habitual (i.e., automatic). Studies that have attempted to disentangle these use cases have found that habitual patterns of use are associated with poorer mental health and wellbeing whereas deliberate use patterns have small positive associations with mental health and wellbeing.[10,11] As examples of positive use cases, 87% of young people ages 14-22 search online resources for mental health information, including information about anxiety and depression when they are struggling.[8] About a third of teens and young adult social media users report finding enhanced social support[39] and other benefits including reduced anxiety, loneliness and depression.[8]

The economics of DTs have not prioritized adolescent wellbeing, however. The attention economy and surveillance capitalism,[40–42] as they have been called, depend on maintaining user engagement to generate ad revenue while extracting and monetizing user preferences and behaviors, often for the purpose of further engaging users. The former calls into question any potential of the current incentive structure to support adolescent wellbeing. The latter raises

important questions about privacy and the appropriateness of exposing adolescents to DTs that record and monetize their behaviors.[43] Meanwhile, DTs risk exposing adolescents to information ecosystems where harmful, erroneous and facile content is pervasive. [44,45] In this context, there is a need to support adolescents' ability to intentionally and not habitually use DTs, and to recognize when DT use is deleterious and be able to disengage from it.

Adolescent Wellbeing in the Digital Age

Recent research on adolescent wellbeing is consistent with decades of research on adult wellbeing.[46] The ability to stay attentive and engaged with what one is doing, persevere through challenges to attain goals, experience a general sense of optimism and hope for the future, and develop and maintain nourishing, connected social relationships are key aspects of wellbeing [47]. Models of adult and adolescent wellbeing have focused on identifying and operationalizing constituents, but for the most part have not identified whether key constituents are traits or can be learned, and have also lacked a framework for increasing the constituent skills on which wellbeing depends. Dahl and colleagues[12] reviewed and synthesized decades of psychological and neuroscience research to propose a four pillar, training-based model of wellbeing that consists of awareness, connection, insight and purpose skills (ACIP). Critically, Dahl and colleagues'[12] model identified skills within each ACIP pillar that have demonstrated plasticity and can be intentionally strengthened.

Awareness. The Awareness pillar consists of the skills that enable us to regulate our attention. Mindfulness, the ability to intentionally attend to the present moment with acceptance is a key awareness skill. Meta-awareness, or the ability to monitor the on-going flow of thoughts, emotions and sensory experiences, is another core awareness skill. In an important study, American adults reported paying attention to what they were doing only about 50% of the time.

Critically, being distracted from the present moment was associated with less happiness and higher negative affect across nearly all activities.[48]

Social media has been called the attention economy because their primary design function is to capture and hold users' attention.[43] The process of algorithmically curated content continually engaging attention is a kind of attention capture loop that requires considerable meta-awareness and self-regulatory skill to exit. Dahl et al.[49] used the term *experiential* fusion – the lack of recognition that what one is experiencing is simulated or fabricated – to describe this phenomenon.

They provide the analogy of watching a movie and being so immersed that one forgets one is watching a movie. As soon as one remembers that one is watching a movie, however, a distance is created between the movie and one's experience. Shifting from fusion to an awareness of an experience is known as decentering.[50] Decentering abilities have been associated with reduced distress symptoms and increased wellbeing, and identified as a core target mechanism in the treatment of adolescent internalizing symptoms.[51–53] Other awareness skills such as mindfulness have been cross-sectionally and prospectively associated with adolescent wellbeing and reduced depressive and anxiety symptoms as well.[54–57]

Connection. The connection pillar consists of skills that are important for healthy social relationships. These include qualities such as appreciation, gratitude, kindness, and compassion. Connection is not simply about the number of social connections, but rather the quality of those connections and crucially, how one perceives one's social relationships.

Social scientists differentiate social isolation (the absence of social interactions) from loneliness (the perception or feeling of being alone or lacking belongingness).[58] Most adolescents routinely have social interactions (e.g., school) and spend considerable time on

social media, but in 2023 around 25% of the world's adolescent and adult population reported regularly feeling lonely; more than 50% felt sometimes lonely.[59] Cross-sectional research with adolescents has observed that connection skill is associated with lower levels of loneliness and higher levels of life satisfaction and wellbeing.[56] According to the ACIP model, it is possible to train feelings of social connectedness and reduce loneliness by practicing gratitude and appreciation for even the incidental social interactions that occur day to day.

Insight. Insight is the most scientifically novel pillar proposed by Dahl et al.[12] It may be particularly important for adolescent wellbeing as identity development and agency are core development goals during adolescence,[60] and the self-inquiry practices prominent in insight skill cultivation are highly relevant to making sense of the world. Insight skills provide for a curiosity-driven understanding of how our beliefs and expectations of ourselves influence our perception and experience of the world. In Dahl and colleagues'[12] presentation, insight into how one relates to self-narratives are crucial for wellbeing because this understanding can open new ways to understand one's self and the world.

Insight skills may be an antidote to certain patterns of thought common in internalizing disorders that are typical features of adolescent development. Cognitive fusion is similar to experiential fusion except that it describes the process by which intrusive and repetitive negative thoughts that are assumed to be literally true overly influence behavior.[61] The unique characteristics of adolescent development may amplify the risks of experiential and adjacent phenomena such as cognitive fusion through DTs.[9] Cognitive defusion, also called metacognitive insight, is the process of decentering coupled with the recognition (i.e., insight) that thoughts and associated emotions are simply thoughts and associated emotions, not the things they seem to represent.[62,63] Skill in cognitive defusion is thought to be a primary mechanism through which

therapeutic modalities such as cognitive-behavioral therapy operate.[52] Wellbeing trainings have been shown to increase this capacity, and several studies have observed that wellbeing training related increases in this skill mediate later improvements in distress and wellbeing.[52,64–66]

Purpose. Purpose is about finding our true direction in life and clarifying our values. Dahl et al.[12] uniquely emphasize the importance of finding value in daily life. Similar to insight, purpose is not so much about finding something more purposeful to do with one's life, but finding meaning and purpose in that which we are already doing. Relatively little research has examined the effects of DT use motivations on mental health and wellbeing, but it is easy to imagine that use patterns and consequences of DTs may differ depending on the use purpose and the value one hopes to find. Extant data bear out this assertion. Adolescents who use social media with a focus on physical appearance report lower body satisfaction and wellbeing.[44] In another study, using social media for fun and entertainment predicted fewer depressive symptoms and less problematic social media use (compared to adolescents looking for social connections and adolescents using social media as avoidance).[67]

Purpose as Dahl et al.[12] defined it is associated with greater wellbeing and reduced distress in adolescents.[47,56] Wellbeing training has been shown to increase purpose.[68,69] It remains to be tested whether wellbeing trainings can promote adaptive and reduce deleterious motivations to use DTs, but value-aligned messaging around adolescent autonomy and social justice led to greater motivation to control social media use in one experiment.[70] Based on the reviewed data, we predict that increasing a sense of purpose in daily activities would reduce problematic DT use and possibly use overall.

Digital Wellbeing Training

As we have illustrated in the prior sections, a defining feature of the ACIP model is that

the skills within each pillar demonstrate plasticity and the potential to be strengthened through training. There is growing evidence that digital wellbeing trainings may improve ACIP skills, mental health and wellbeing. For example, our group has conducted a series of studies on the Healthy Minds Program smartphone app (HMP) as well as other digital wellbeing trainings based around the ACIP framework. The HMP provides didactic, podcast style summaries of research on the relationships between ACIP skills and wellbeing, and training in meditation practices intended to strengthen these skills. Other ACIP structured interventions include a video-based intervention for Mexican healthcare providers and a synchronous Zoom-based college course on flourishing. In all of these studies, we have observed evidence for intervention-related improvements on ACIP skills, mental health and wellbeing.[68,69,71,72] Perhaps most important, we have observed intervention-related improvements on exactly the domains of ACIP skill that might allow an adolescent to intentionally and not habitually use DTs (i.e., mindfulness), recognize when DT use is deleterious and disengage from it (e.g., meta-awareness, cognitive defusion, attention control), and promote DT motivations associated with positive outcomes (e.g., purpose).

Relatively speaking, research on DT interventions to promote adolescent wellbeing is in its infancy. Results from studies testing apps or other DT interventions on sexual reproductive health behavior, rumination, anxiety and depressive symptoms, stress perceptions, healthy eating, and hopelessness are promising.[73–79] A few studies have examined mindfulness-based smartphone apps in adolescents. For instance, in a pilot trial of 80 ruminative adolescents, Hilt and Swords[80] reported app feasibility and reduced rumination following the intervention. A later RCT of the same app in 152 ruminative adolescents found that the app predicted significantly reduced rumination, anxiety and depression following the three-week intervention.[74]

Although this early evidence indicates that well-designed DT interventions are accessible, can be feasibly implemented, and may effectively improve adolescent wellbeing, as a nascent area of research, there is a need for greater methodological rigor and larger scale studies. For example, few studies have used active control conditions to control for non-specific effects and most studies rely on self-reported outcomes. Critical to the model we present in subsequent sections, few studies have attempted to examine processes of change and fewer still have assessed the ACIP skills that might support adaptive adolescent DT use.

Wellbeing Skills as An Antidote to Unhealthy Digital Technology Use Patterns

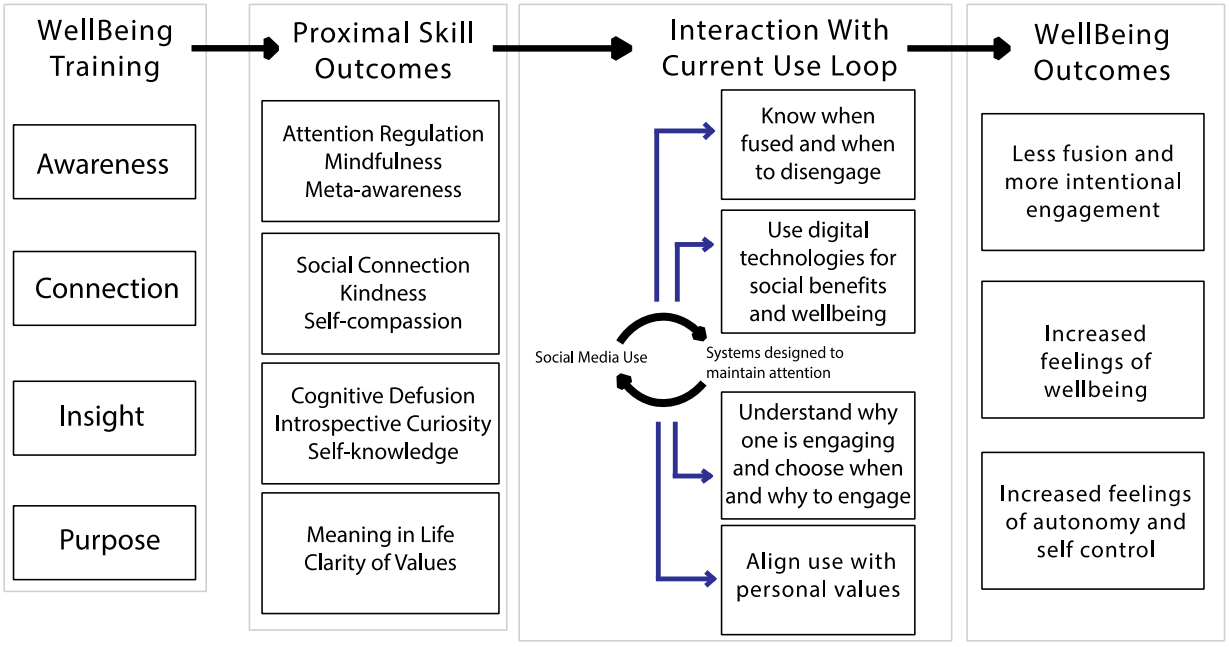
Unhealthy DT use patterns are illustrated in Figure 1 and characterized by fusion; the capture of attention by DTs designed to capture attention and the compulsion to continue to engage with the DT as a consequence. In addition to experiential or cognitive fusion, DTs may expose adolescents to content that has the potential to harm, including inappropriate sexual content, unrealistic presentations of bodies and faces, and violence,[44,45] even when such content is not sought by an adolescent user. Adolescents may also be exposed to misinformation and disinformation that provide a rich context for other sorts of harm.[81] Especially for females, data suggests that unhealthy DT use patterns are associated increased feelings of loneliness, social isolation, negative self-narratives, and internalizing symptoms.[82]

Figure 1. ***A Theoretical Model of Typical Digital Technology Use Among Adolescents***

A fused DT use loop is not the only way to engage with DTs.[10,11] In Figure 2, we present a theoretical model of DT engagement supported by ACIP skills. We theorize that awareness

skills provide the cognitive workspace to monitor how one is using DT and the effect that use is having on thoughts and emotions, while affording the ability to disengage when use is deleterious to wellbeing. Connection skills such as generosity and compassion to others may shape DT use towards prosocial use cases and outcomes that reinforce feelings of connection. As previously described, insight skills such as understanding one's self-narratives to be narratives and not reality may be able to disrupt negative use patterns by providing an understanding of the underlying mechanisms driving use (e.g., negative self-image, boredom, loneliness). Through this understanding, insight skills may disrupt compulsive patterns of DT use based on social comparison or fear of missing out.[83] Clarifying one's values and how to express those values in daily life may promote purposive engagement with DT guided by awareness of these values.

Figure 2. ***A theoretical Model of Adaptive Digital Technology Use Based on Wellbeing Skills Training***



Note. Figure 2 illustrates our proposition that strengthening wellbeing skills will allow adolescents to make intentional decisions about their technology use that are guided by their

values and goals, while possessing sufficient awareness of and the abilities to regulate and adapt DT engagement behaviors so that they support rather than diminish wellbeing.

Personalized, Universal Adolescent Wellbeing Training Through Digital Technologies

Prevention scientists have struggled to universally implement effective interventions in general, and with adolescents in particular. For example, to improve adolescent mental health, researchers have attempted universal school-based implementations of cognitive behavioral therapy and mindfulness-based interventions. Results from these studies have been discouraging.[84] Attempts at universal intervention to reduce substance use and abuse, early and risky sexual behaviors, and smoking, among other health outcomes, have also been discouraging.[85]

Universal intervention implementations typical occur after promising evidence from smaller trials and targeted intervention studies in which specific subpopulations have enrolled. The reasons promising interventions at small scale or with targeted subpopulation fail when universally implemented are complex. One commonly cited reason is implementation fidelity.[86] As interventions scale-up, it becomes more challenging to maintain fidelity of implementation. A less discussed reason for why promising targeted interventions can fail at scale is that researchers may underestimate population-level heterogeneity and therefore overestimate the generalizability of small trial results.[87] As sample sizes get larger, samples become more heterogenous, and a one size fits all contexts approach, which is the standard definition of implementation fidelity, may produce more variable effects.

DTs designed to promote wellbeing may help to mitigate the negative effects of DTs on adolescents while overcoming many of the challenges associated with universal intervention.[88,89]

Unlike in-person interventions, DTs have the potential to provide a standardized intervention framework that is flexible to context. Choice is a critical ingredient in behavior change.[90] Introducing the ability to choose a pathway through a curriculum may be especially appealing to adolescents for whom agency is a core developmental concern. DTs can provide consistency through a standardized intervention framework and choice simultaneously, while recording objective metrics of adherence and engagement that can later be analyzed to understand how choice and standardization interact. Furthermore, because it is feasible to collect very large datasets when studying DT interventions, it is possible to generate personalized prediction models of optimal intervention pathways using AI. In subsequent trials of new participants, the validity of these predictive models can be tested and refined. Further on the horizon, it may become possible to train algorithms to accurately detect – by integrating app, wearable sensor and other data streams (i.e., digital phenotyping) – various internal states and generate real-time, adaptive interventions that support adolescent wellbeing.[91]

In our model, wellbeing skills underly healthy development across the lifespan and provide a substrate for healthy adaptation to a quickly changing world, including how to develop healthy DT use habits. Digital wellbeing trainings focused on adaptive mindsets,[79] positive psychology,[89] mindfulness,[74] and Dahl and colleagues'[12] multidimensional wellbeing framework[69] have demonstrated promise in reducing psychological symptoms and increasing wellbeing. Critically, there is accumulating evidence that at least some of these interventions also strengthen ACIP skills, and that strengthening these skills mediates improved wellbeing later on.[52,65] Whether strengthening these skills alters DT use is a critical question for future research.

Limitations and Cautions

We are optimistic that DTs can be utilized to support adolescent wellbeing at scale under

the right conditions. For instance, progress has been made in developing DTs that reduce overall DT use and help users evaluate the veracity of information in the digital world.[92,93] Smartphone apps, text message based intervention, web browser extensions, modified social media applications, and video-based programs, to name a few, each have advantages and disadvantages, and it will require a considerable amount of research to understand which approach is best for whom and when. Meanwhile, new DTs are continually being developed to succeed in the attention and surveillance economies, sometimes with tragic consequences. Adolescent use of emergent DTs such as AI companions are growing, as are anecdotal tragedies that suggest new hazards.[30,31] The need for rigorous research on these issues is urgent and growing.

Society has a responsibility to limit the potential harms posed by DTs and to try and maximize their benefits. There is significant debate about, for example, whether DTs such as smartphones should be restricted during the school day. We suggest that the conversation has not been framed correctly. Restricting smartphone use during the school day may not result in improved adolescent wellbeing or healthier DT use patterns.[94] If we do not provide adolescents with the skills to adaptively navigate their DT use (inside or outside of school), or train the skills that help adolescents to monitor the effect their DT use is having, or strengthen the ability to regulate their behavior when those effects are harmful, why would we expect school day restrictions to improve adolescent wellbeing?

This framing obscures a more essential problem about the conversation surrounding DTs. In contexts such as schools where it is possible and appropriate to regulate DTs, rather than asking whether smartphones or other DTs are harmful and attempting to restrict them if they might be, we might instead ask if they are beneficial and allow them only if they are. From this perspective, restricting phones in schools makes sense. There is no evidence that widespread

adoption of DTs in schools has improved achievement on average or reduced inequalities in achievement,[95] but there is evidence that DTs such as smartphones are problematic in schools.[96] While restricting phones in schools alone may not solve adolescent loneliness or depression or unhealthy outside of school uses of DTs,[94] doing so combined with evidence-based, developmentally appropriate strategies to improve wellbeing skills may. We are hopeful that well designed, developmentally appropriate wellbeing trainings, including DT-based ones, can promote wellbeing skills in adolescents, allowing adolescent to navigate and use DTs in healthy ways.

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