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Co-designing a digital mental health platform, "Momentum", with young people aged 7–17: A qualitative study

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Abstract

Introduction: Digital mental health interventions (DMHIs) offer a promising alternative or adjunct treatment method to face-to-face treatment, overcoming barriers associated with stigma, access, and cost. This project is embedded in user experience and co-design to enhance the potential acceptability, usability and integration of digital platforms into youth mental health services.

Objective: To co-design a digital mental health platform that provides self-directed, tailored, and modularised treatment for young people aged 7–17 years experiencing anxiety, depression and other related problems.

Methods: Sixty-eight participants, aged 7–17 years, engaged in one of 20 co-design workshops. Eight workshops involved children ($n = 26$, $m = 9.42$ years, $sd = 1.27$) and 12 involved adolescents ($n = 42$, $m = 14.57$ years, $sd = 1.89$). Participants engaged in a variety of co-design activities (e.g., designing a website home page and rating self-report assessment features). Workshop transcripts and artefacts (e.g., participants' drawings) were thematically analysed using Gale et al.'s Framework Method in NVivo.

Results: Six themes were identified: Interactive; Relatable; Customisable; Intuitive; Inclusive; and Personalised, transparent and trustworthy content. The analysis revealed differences between children's and adolescents' designs and ideas, supporting the need for two different versions of the platform, with age-appropriate activities, features, terminology, and content.

Conclusions: This research showcased co-design as a powerful tool to facilitate collaboration with young people in designing DMHIs. Two sets of recommendations were produced: 1) recommendations for the design, functionality, and content of youth DMHIs, supported by child- and adolescent-designed strategies; and 2) recommendations for clinicians and researchers planning to conduct co-design and intervention development research with children and adolescents.

Keywords

adolescents, anxiety, children, co-design, depression, digital mental health interventions, digital technology, mental health, qualitative, youth

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Introduction

It is estimated that the global prevalence of mental health disorders in children and adolescents is almost 15%.[1] These figures are reflected in Australian data, with 13.9% of young people aged 4–17 years having a mental health disorder, almost 70% of whom have anxiety or depression.[2] Anxiety and depression in young people are associated with poor school attendance,[3] poor sleep quality,[4] greater emotion regulation difficulties,[5] suicidal thoughts and attempts, and dysfunctional functioning later in life.[6–8]

Despite several reforms in mental health service provision for young Australians, including increased accessibility,[9,10] only 50% of Australian youth experiencing mental health problems receive help of any kind, and only 2% receive specialist intervention.[2,6] There is a lack of available mental health services, for example, Headspace reported that in 2018 there was an average 25.5-day wait time for first appointment, with workforce capacity reported as the main influencing factor.[11] Since the start of the COVID-19 pandemic in 2020, mental health conditions have increased globally,[12] with some countries (e.g., France, Italy, Mexico, New Zealand, the United Kingdom, the United States and Australia) reporting that rates of common conditions such as anxiety and/or depression have increased 50% or more compared to previous years. Internationally, the pandemic led to an increased demand on mental health services and workforces,[13] in addition to reduced access to services and longer wait times.[14,15] In the Australian context, the Australian Psychological Society found that 88% of psychologists (n = 1456) reported a rise in demand for services since the start of the COVID-19 pandemic, with one in three psychologists unable to take new clients due to overwhelming demand.[16] The Australian Psychological Society also reported long wait times; in some cases up to 6 months.[16]

In addition to the availability of clinicians, young people face numerous obstacles to seeking, accessing, and engaging with mental health treatment, including limited knowledge of resources and avenues for help-seeking; perceived social stigma; concerns about the therapeutic relationship; and systemic barriers such as financial costs.[17–19]

Digital mental health interventions

Digital Mental Health Interventions (DMHIs) show considerable potential to bridge the gap in mental health service provision and provide much needed prevention and treatment.[20,21] Digital interventions include web-based programs, mobile technologies, and virtual reality, which may be delivered as standalone treatments or as adjuncts to in-person treatments.[22] DMHIs have the potential to reduce or remove barriers to access and engagement with treatment by creating secure and anonymous access,[23] providing opportunities for stepped care to find the optimal level of therapeutic relationship suited to the individual,[24,25] and significantly reducing costs and logistical barriers to mental healthcare.[26] Digital Cognitive Behavioural Therapy (CBT) interventions have been shown to be particularly effective in reducing symptoms of youth anxiety[27,28] and depression.[20]

Despite the benefits of DMHIs, youth engagement remains far lower than the apparent demand for mental health treatment.[29] Clarke et al.'s systematic review of 28 studies evaluating online mental health promotion and prevention interventions for 12–25-year-olds found that for many interventions, rates of dropout and non-completion were moderate to high.[29] While more research is needed to understand the disparity between the need for interventions and young people's engagement with DMHIs, several reasons have been identified, including technical issues,[30] privacy concerns,[30] limited personalisation,[30] lack of human interaction,[31] and failure to include young people in the DMHI design process.[26,32,33] A 2019 review of randomised control trials evaluating the effectiveness of DMHIs for those aged 6–18 years with depression and anxiety found that of the 34 interventions identified, none reported involving young people in the design.[34] While Bevan Jones and colleagues' 2020 review of co-designed youth digital mental health technologies found 25 research articles (reporting on 30 DMHIs) that had involved children and young people (aged 8–27 years) in the design of the intervention, only five involved children under the age of 12.[35]

Failure to include young people in the design of DMHIs can lead to misalignment between young people's needs and preferences and the characteristics of developed programs (e.g., not age appropriate or sufficiently engaging).[33,36] Most young people interact with technology daily and have a sophisticated and nuanced understanding of their needs and wants from online platforms,[35] therefore, partnering with young people in the design process can provide unique insights into their experiences and viewpoints regarding DMHIs.

Enhancing engagement through co-design

Co-design is a crucial component of research and development, referring to the meaningful engagement of relevant stakeholders in the design process.[37,38] It involves seeking out the lived experiences of potential end-users and their networks, understanding their needs and preferences, and taking into consideration contextual factors, in order to design tools, interventions or products that facilitate end-user engagement and uptake.[35,39] End-user engagement and partnership is increasing being recognised as a key component of implementation science,[40,41] with several prominent implementation science frameworks

(e.g., EPIS framework, PRECEDE-PROCEED, Plan-Do-Study-Act cycles, and PARIHS), explicitly referencing stakeholder engagement).[40]

Co-design goes beyond consultation and observation, requiring researchers and designers to actively collaborate with end-users to design solutions.[38] Co-design may incorporate a range of activities to engage young people, such as discussions, storytelling, mapping exercises, drawing, and prototype feedback.[42,43] Co-design approaches with young children and adolescents should ensure that research activities are engaging, age appropriate (e.g., consideration of reading abilities), and culturally relevant.[35,38] Other considerations when co-designing with young people include the creation of a comfortable environment (e.g., non-clinical); awareness of naturally occurring peer groups in research (which have the potential to either facilitate or hinder conversations); and prioritisation of safety and wellbeing (e.g., regular breaks and provision of snacks).[35,38]

Study objective and research questions

The study objective was to co-design a new DMHI, specifically, a digital platform that provides self-directed and tailored treatment for young people aged 7–17 years experiencing anxiety, depression and other issues that can impact on wellbeing (e.g., sleep and substance use). The research questions the study sought to answer were:

1. What are young peoples' preferences for the 'look and feel' of a new digital mental health platform?
2. What are young peoples' perceptions of how a digital mental health platform should function?
3. What are young peoples' perceptions about what makes a digital mental health platform engaging (including assessment and treatment components)?

Methods

Study design

The methodology for this study was guided by participatory design practices and co-design principles that emphasise the importance of 1) enabling young people to have a central role in influencing the outcome of the e-mental health design process, 2) allowing a mutual learning process to explore e-mental health design solutions collaboratively and creatively, and 3) providing co-creation opportunities that allow a diverse range of young people to express their needs for the digital mental health platform in their own ways.[44–46] Guided by these principles, and consistent with a *designing with* as opposed to a *designing for* mindset,[47] this study used a generative toolkit as the method of data generation.[47] Generative toolkits comprise a variety of components (e.g., templates, worksheets), that facilitate co-design through the production of artefacts (tangible outputs, e.g., drawings, completed worksheets).[47] Some parameters for the workshops were established in prior study stages including the intended output (i.e., a digital mental health platform for young people) and a platform name. The name "*Momentum*" was generated through two separate phases, conducted with young end-users of a different digital mental health platform: a) open answer questions (nominating potential names and themes; n = 506) and b) a survey of young people (n = 1026) to rank order subsequent name options.

Participants and recruitment

Young people were eligible to participate if they were: i) aged between 7 and 17 years, ii) had current or past experiences with emotional problems or experience using digital health or mental health apps, and iii) available to participate in a face-to-face workshop at one of three universities in Brisbane, Australia. Participants were recruited from November 2020 to February 2021 through convenience sampling, with advertisements distributed through social media, professional networks, and via Kids Helpline (a national online and phone counselling service for people aged 5 to 25 years). We also collaborated with a Special Assistance School; an accredited non-state school equipped to support adolescents with mental health challenges. Interested participants and/or their caregivers completed an online expression of interest and were contacted via email or telephone to check their eligibility for the study. Some of the participants recruited through convenience sampling had existing relationships with researchers. Participants were allocated to workshops where they did not know the facilitator and all data were de-identified, using participant pseudonyms.

Data collection procedures and materials

Informed written consent was received by all participants and their caregivers prior to participation. Participants were allocated to one of 20 workshops based on their age and preferences for workshop time and location. Workshops consisted of 2–7 participants. Workshop facilitators had all completed a minimum 4 year degree and were undergoing advanced level training, or had a PhD, in an area of health (7 = psychology, 1 = speech pathology, 1 = health innovation), with at least one facilitator present in each workshop who had experience as a mental health practitioner. At the beginning of the workshops, facilitators oriented the participants to the aims of the project and developed a shared understanding of e-mental health. The facilitators sought to promote a collaborative working space by conveying the openness of the research team to working with young people and highlighting the value-add of working together. Participants then engaged in an ice-breaker game where they received a sheet with photos

displaying different chocolates from a well-known Australian brand, Favourites™. Each chocolate was linked to specific personality traits, for example, Cherry Ripe™ was linked with the trait of 'Artistic'. Participants chose the chocolate that matched their own personality traits and had the option to talk about their choice (or not) with group. They were also given a chocolate to eat. This game was approved by parents and teachers. The icebreaker activity was followed by up to six activities: 1) Design a website[1] home page, 2) Design a logo, 3) Design a character, 4) Rate the importance of self-report assessment features (e.g., see one question at a time) using an ink stamp and stamping sheet. The number of stamps that could be given ranged from 1–5, with five indicating greater importance, 5) A terminology activity (feedback and/or alternative suggestions for terminology), and 6) A 'do not' activity (what should be avoided in the platform design). Participants in all workshops completed Activity 1; however, the completion and order of Activities 2–6 was more flexible and depended on the flow of conversation and group dynamics.

Each participant was provided with a generative toolkit which guided the workshop.[47] The toolkit included a pack of coloured pencils; templates for drawing characters, webpages, and logos; existing e-mental health webpages; a terminology worksheet; and a worksheet listing assessment features, accompanied by an ink stamp to assign value to features (e.g., three stamps out of a potential five). The toolkit was piloted and tested in an initial workshop with two facilitators and four participants. This workshop was video recorded for facilitator training. Data from this pilot workshop was included in the analysis.

Facilitators aimed to seek input from all participants via a range of communication modalities, e.g., writing, drawing and/or verbally. Workshops were approximately two hours in length, at the conclusion of which, participants filled out a post-workshop survey about their experiences participating in the co-design workshops (Supplementary File 1). Snacks and water were provided during the workshops, and each participant received a thank you gift voucher valued at $20AUD. Workshops adhered to COVID-19 social distancing rules. Workshops were audio-recorded, and photographs were taken of artefacts (e.g., drawings, worksheets), with participants' consent. All data were de-identified using pseudonyms selected by participants. Post-workshops, facilitators produced reflective field notes about their impressions of workshop interactions and emerging patterns in participants' responses.

Facilitators who were trained mental health practitioners monitored participants for signs of distress during the workshops. They also checked in with participants during breaks. Participants were told that they could withdraw from the study at any time. They were provided with mental health helpline telephone numbers and web addresses.

Data analysis

Transcripts and artefacts were thematically analysed using an inductive approach, guided by Gale and colleagues' six-stage Framework Method.[48] During *Stage 1*, audio recordings were transcribed verbatim by a professional service. In *Stage 2*, RB and KL familiarised themselves with the data by checking transcripts for accuracy against audio recordings. JR and two undergraduate student interns reviewed all artefacts and created reflective memos for each. During *Stage 3*, five researchers (RLB, KL, JKR, TJ and BR) independently open coded a random 15% sample of transcripts and artefacts using NVivo V12. In *Stage 4*, the five researchers met to discuss their codes and developed a preliminary framework by grouping conceptually related codes, hierarchically structuring codes, and reviewing reflective fieldnotes. The researchers independently applied the preliminary framework to a second 15% random sample of data. The researchers met again to refine the framework by adding new codes, relabelling existing codes, merging codes, and adjusting the hierarchical structure. During *Stage 5*, all data files, including files used in the initial rounds of coding, were allocated between RLB, KL and JKR, who applied the amended framework. In *Stage 6*, data were charted into a matrix using the 'matrix coding' function in NVivo to compare data from child and adolescent workshops. During *Stage 7*, RLB, KL and JKR interpreted the matrix by identifying patterns in data across the two workshop groups and creating summaries of data trends. JKR, SM and KL identified overarching themes by reviewing the analytic framework, matrix summaries and reflective fieldnotes.

Ontology, epistemology and researcher reflexivity

The research team adopted a constructivist stance in their data analysis, understanding that meaning is collaboratively shaped by participants and research team members, who draw upon their individual perspectives, experiences, and interpretations. They recognised that knowledge is co-constructed through shared interactions between participants and researchers. The researchers were aware of how their backgrounds and training in mental health and psychology might impact data interpretation. To mitigate potential researcher bias, the researchers employed the following strategies: engaging multiple coders in the generation of a coding framework (including a blinded coding sample), team discussions, and a review of reflective fieldnotes during the data analysis process.

Trustworthiness

Trustworthiness in qualitative research can be demonstrated through credibility, transferability, dependability, and conformability.[49] *Credibility* was achieved through 'investigator

triangulation' and 'method triangulation'.[50] Five researchers were involved in the coding, analysis and interpretation of data, including blinded reviews to develop the coding framework (investigator triangulation). Multiple methods of data collection were used including verbal discussions, drawing, and stamping sheets (method triangulation). Detailed descriptions of the study context, participants and analysis process enhanced the *transferability* of findings.[50] *Dependability* and *confirmability* were achieved through a clear and transparent audit trail of data collection and data analysis,[50] including verbatim transcripts, the establishment of a coding framework, and comprehensive study records.

Results

Study characteristics

Eight child workshops (with 26 children) and 12 adolescent workshops (with 42 adolescents) were conducted. Participants were aged 7–17 years (m = 12.60 years, sd = 3.02 years), with 23.5% identifying as male, 72.1% as female, and 4.4% as a gender other than male or female. Participants included three people (4.4%) who identified as Aboriginal or Torres Strait Islander. Twelve adolescents (28.6%) attended a Special Assistance School. Within the sample, 67.6% of participants endorsed that they were currently experiencing emotional problems or had experienced them in the past, and 76.5% endorsed that they had experience using digital health or mental health apps. No participant withdrew from the study. Table 1 displays demographic information.

Themes

Six overarching themes were identified: 1) Interactive, 2) Relatable, 3) Customisable, 4) Intuitive, 5) Inclusive, and 6) Personalised, transparent and trustworthy content. Analysis revealed notable differences in the responses of children and adolescents, which are summarised in the following theme descriptions. A brief summary of themes is presented in Table 2, followed by a more detailed overview of each theme, supported by quotes and artefacts (drawings).

Interactive. Participants expressed that it was important to provide young people with fun and interactive ways to initiate and maintain engagement with the platform. They described and drew visual representations of different ways in which interactivity could be incorporated into the platform, including creating an avatar, interaction with characters, games and activities, rewards, using a variety of media types (videos, images and text), and interactions

Table 1. Participant characteristics.

	Children workshops	Adolescent workshops
Number of participants, n	26	42
Age (years), mean (standard deviation), range	9.42 (1.27), 7–12[a]	14.57 (1.89), 11–17[a]
Gender, n (%)		
Male	11 (42.0)	5 (11.9)
Female	15 (58.0)	34 (81.0)
Other	0 (0)	3 (7.1)
Aboriginal or Torres Strait Islander, n (%)	2 (7.7)	1 (2.4)
Current or previous emotional problems, n (%)	17 (65.4)	29 (69.0)
Digital health or mental health app use, n (%)	20 (76.9)	32 (76.2)

[a]11- and 12-year-olds were assigned to either child or adolescent workshops based on their preferences, e.g., peer group or workshop location.

Table 2. Summary of themes.

Theme	Description
Interactive	The platform should be fun, interesting, and engaging.
Relatable	The platform should normalise mental health struggles and have features that platform users can identify with.
Customisable	Platform users should be able to tailor the platform to their individual preferences through the provision of options.
Intuitive	The platform should be easy to use and navigate.
Inclusive	The platform should be inclusive, non-gendered and adaptable for a range of user needs.
Personalised, transparent and trustworthy content	Information, resources and treatment materials should be tailored to the individual, clearly explained to platform users and come from reputable sources.

with other platform users via a chat function. One common suggestion was the incorporation of an interactive "nature" element. Nature was a prevalent theme across participants' responses and drawings (Figure 1), viewed as a representation of calmness. Participants often gave nature symbols (flowers, trees and rainbows) an interactive function. For example, Figure 1 shows how nature can be incorporated into videos (top left image), breathing activities (top right image) and as a measure of progression ("self love tree" image). Flowers, plants and trees in particular were viewed as a symbol of growth and progression. The adolescent who drew the "self love tree" explained that accessing Momentum resources

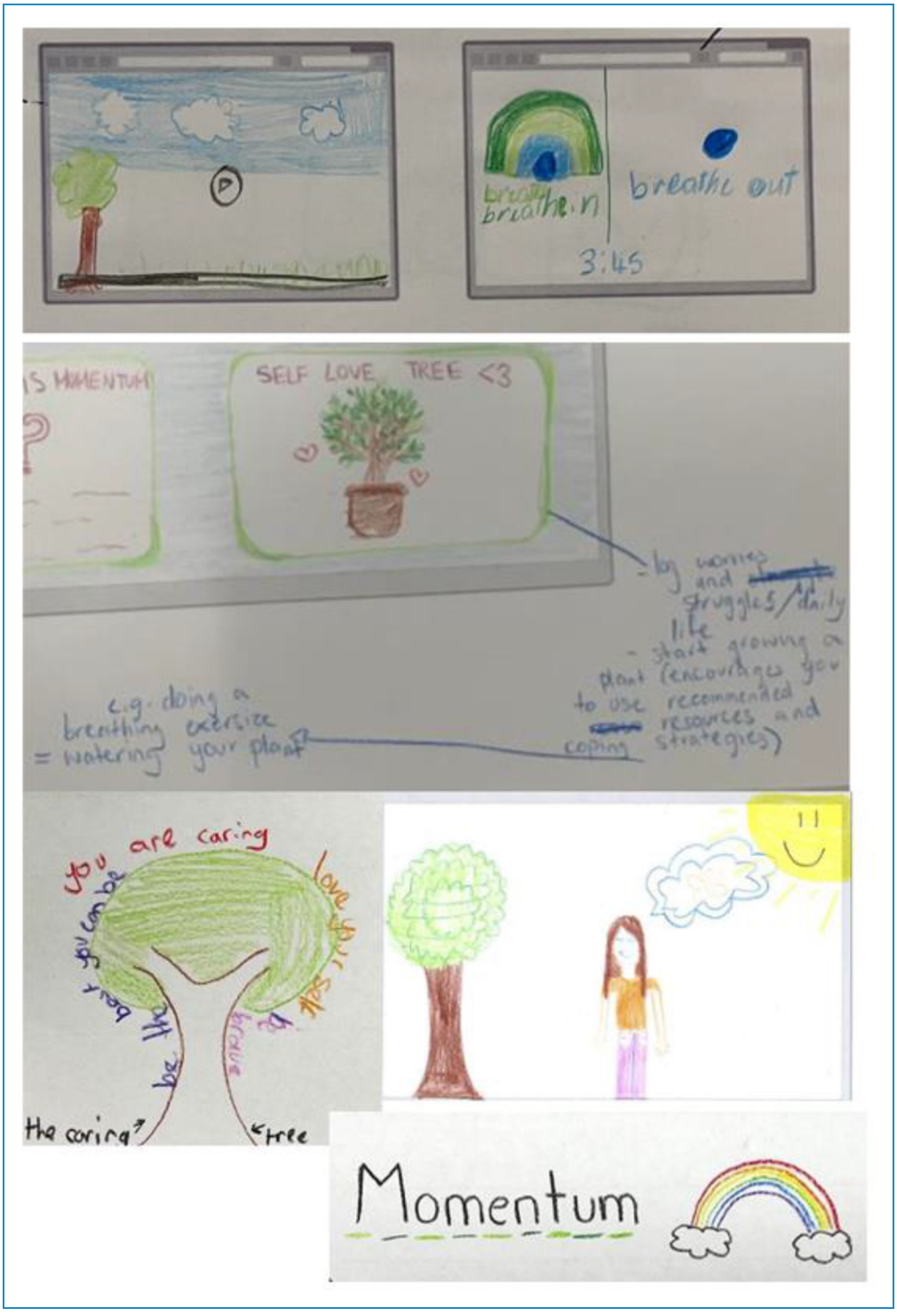

Figure 1. Participant platform designs depicting nature.

and completing calming strategies (e.g., breathing exercises) would act as a watering feature, that helps the user's tree grow.

> *Something like breathing exercises or something like that. And if you do it then it will give you some … water to water your tree, that kind of thing*. (Adolescent workshop)

Having interactive features that allowed platform users to track activity such as their progression through the platform was considered to give end-users ownership over their individualised programs. Other tracking suggestions included journal/diary functions (featured more in adolescent responses) and recording emotions or feelings using emojis (featured more in child responses) or a numerical score (Figure 2). Figure 2 shows that some participants combined this "check-in" of emotions with a calendar function.

> First participant: *It would come up on your screen every day and it could say, 'how are you feeling?' You could do, like*

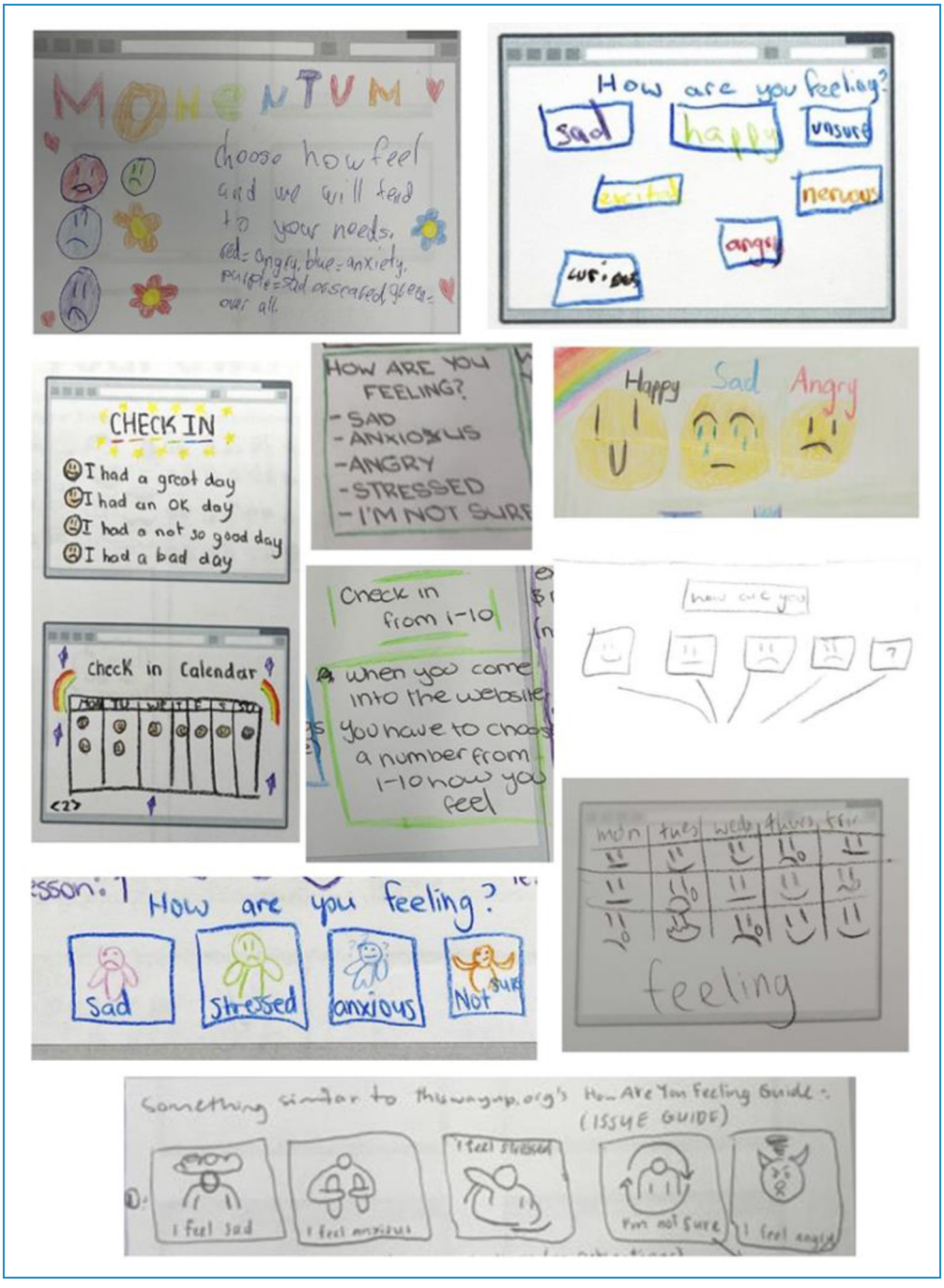

Figure 2. Participant platform designs depicting functions to track users' emotions.

emojis, like if you're feeling good you'd do a happy face, or bad you could …

Second participant: *Yeah, like a daily check in, every day, you just come and you do—out of your five—if you're like not good at all, or you're feeling better …* (Children workshop)

There were three views on what the purpose of interactive activities should be. The first was to offer games or other activities as a reward for completing treatment content. This view was more prevalent among child responses. It should be noted however, that some participants cautioned that games could potentially lead to feelings of frustration which could counter the objectives of the platform.

Participant 1: *You could unlock new de-stress games …*

Participants 2: *You could have this thing … with the games you could have like the more activities you do that's like beneficial to your mental health the more time you get … and then like you're doing the stuff good for your brain but then you're also like having fun afterwards because you've like earned that fun*. (Adolescent workshop)

Sometimes games can make you feel a bit angry, when you lose something. When you can't get something that you want … because most games don't really calm you down because they make you excited, angry or excited" (Children workshop)

The second view was that the activities should relate to mental health content and assist with the learning and retention of that content (e.g., skills and coping strategies).

You could turn it into – make like puzzles and stuff, but also, kind of make it on like the mental health side, so it's still part of the website, it's not something like completely off topic, like it could be like – oh, I don't know how to explain it – just a crossword of all of the mental health problems. (Adolescent workshop)

The third view on the purpose of interactive activities was that the platform should contain interactive activities such that were "calming" such as meditation, drawing activities, puzzles, audio books, games or yoga to help end-users relax when they felt stressed or anxious. In some instances, this was seen to give users a mental break from treatment content while keeping them engaged with the platform.

I think you just take a break every 15, or half an hour, 30 min. Just take a break to relax. To look through what you've done, and take a little look – break, because you might get a little more anxious if you keep doing it, and doing it, and not taking any breaks… Say you're doing all these quizzes and things, and you've done your lesson already … and you're getting stress because you keep doing it, you could stop for a few minutes and do a little meditation thing. Just with the video, or just by yourself, just a little meditation to cool yourself down … (Children workshop)

Figure 3 depicts a child's drawing encompassing these three types of activities under the headings: "play" (games and rewards), "train" (coping strategies and tools) and "calm" (calming activities for a mental break).

There were drawings of, and discussions within adolescent workshops about, incorporating a social component into the platform where platform users could talk to other users through a chat function. For example, Figure 4 depicts an adolescent's artefact of a webchat function. This feature is seen to function as a means of social connection and an expression of feelings. Discussions included acknowledgment of some of the problems and dangers associated with chat functions. For example, Figure 4 acknowledges the need for a block button, monitoring functions and age restrictions.

… say if there was one person that was talking to me on a webchat that really helped me, you know, you could ask them for information, or they could have an option where you can choose to talk to that person again. (Adolescent workshop)

I think they should be monitored … because there is also the risk of random old people getting on there and there always is that type of stuff. And there's definitely got to be a block button. (Adolescent workshop)

Figure 3. A child's platform design displaying three types of interactive activities.

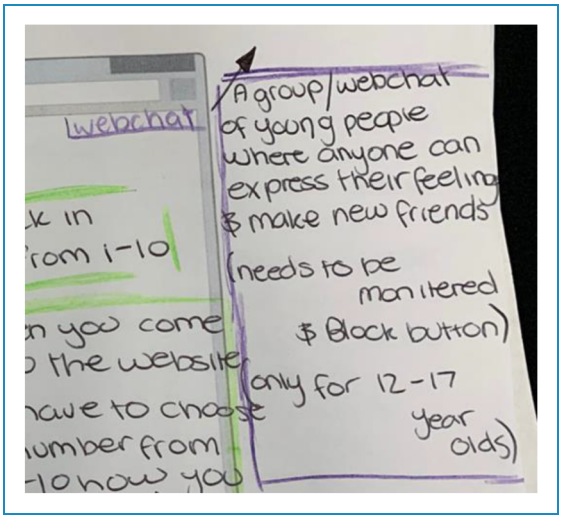

Figure 4. An adolescent's platform design of a webchat function.

Relatable. Participants expressed that the platform needed to be relatable, i.e., a platform they can identify with. Having potential end-users involved in the co-design process meant that end-users could better connect with the platform, as one participant explained:

> *People with mental health issues have actually collaborated on it [Momentum] and put in their ideas for it because a lot of websites that are meant for mental health haven't had people with mental health issues collaborate on them*. (Adolescent workshop)

Adolescents suggested that relatability could be achieved through the normalisation of mental health issues and the involvement of children and adolescents in the design of the platform, whereas children spoke more about personalised characters and the use of colours to facilitate relatability. Adolescent participants recognised the stigma associated with mental health issues and how this could act as a barrier to young people accessing services. As such, it was important to participants that the platform normalise mental health issues by not using pathologizing language and by making platform users feel like they are not alone in their experiences.

> Interviewer: *is there anything that we should not do? … things that you don't like …*
>
> First participant: *I think using the word 'fix' – like fix your mental health or fix this or fix that.*
>
> Second participant: *Yeah, that wouldn't be good.*
>
> First participant: *Because I think it makes it seem like there is something wrong with how you're feeling.*
>
> Second participant: *Because the whole point of a mental health website is like to make yourself feel accepted.* (Adolescent workshop)
>
> *Also, confirmation that like you're not the only person feeling like this and … just like kind of like appreciation for like mentally ill people using this website that like the little things they're doing do matter, and they're like a big step forward for them. And it's also the acknowledgment that the storm will pass at the end of the day.* (Adolescent workshop)

Adolescents recommended including user testimonials to normalise mental health difficulties, which would also enhance trust in the platform and the content it provides. They noted that these accounts of personal experiences with the platform could provide platform users with a source of hope, inspiration, and motivation for overcoming their own difficulties.

> *I guess having someone who's willing to tell their story, or like how they overcame it … and that would be a real person if they were comfortable telling that story, you could use that as examples, so it's not just some kind of made up thing because I don't know, but I would feel that I would want something real, that it's not just kind of made up but a person has actually benefited*. (Adolescent workshop)

Figure 5 is of adolescent artefact which depicts journal entries of how others "got through" their problems. Another suggested avenue for facilitating relatability was through the use of characters and avatars. This was especially prominent in children's responses. Some participants expressed the desire to be able to create a character that represented them personally, for example, choosing a hair colour and style similar to their own. Participants also saw characters as a means to reflect platform users' emotions, or desirable attributes such as bravery.

> *… you can customise like the size and then like a lot of skin colour options and stuff, and I think that would be good because then kids can like actually customise who they personally think they look like, but then add things so they can just kind of like interact with it more*. (Adolescent workshop)
>
> *Well the superheros you could be like either like special powers or emotion powers, or you can do both. So, emotion powers can be like maybe brave and strong can be in in both because it's kinda special and emotive …*

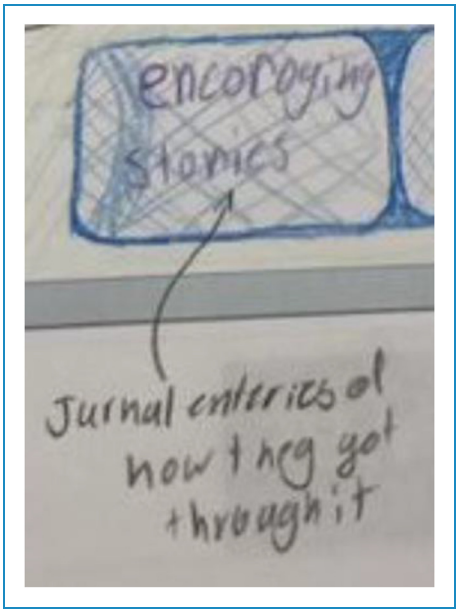

Figure 5. An adolescent's platform design for journal entries.

and you can maybe make other people feel better if they're upset and maybe calm people down. (Children workshop)

Most participants expressed that they wanted characters (whether animated or actors) in videos to be of similar ages to them so they could identify with them. Children wanted videos to include people who were the same age as them or a bit older, and adolescents wanted them to be as close in age to them as possible.

First participant: *You would want to see the kids doing it. But maybe the people talking should be like an 18-year-old … or maybe 16-year-old …*

Second participant: *Yeah, maybe different ages … for different aged kids … Because sometimes people respect people who are older, because they think something will happen if I do something wrong*.

Third participant: *Yeah, and they also think, they know more than me. They're probably right*. (Children workshop)

Colours that reflected emotions were another way participants, particularly children, spoke about relating to the platform. Participants expressed familiarity with colour representation for specific emotions, such as red for anger. Figure 6 shows one example of how a child incorporated colour as a representation of different emotions. Across the sample, young people generally wanted both bright and calming colours (e.g., green and blue) incorporated throughout the platform.

Figure 6. A child's platform design showing how colours can represent emotions.

Customisable. Participants expressed a strong preference for customisation of platform features, particularly themes (colours, backgrounds) and characters/avatars (Figure 7). For some participants, this meant selecting from a set of options and for others it meant creating something unique, for example, selecting hair colour, clothes, and facial features to create a new avatar.

… there's like a big shop but you can get all the things for free like you can choose your own eyes and hair and clothes, and you can just pick it like you just walk over and click it to put it on and then … you can just make your own style. (Children workshop)

You could choose like a different theme, like different colour schemes and stuff because some people might not like the original colours so they might want to be like oh I'd like pink. (Adolescent workshop)

Many participants, particularly children, explained that customisation could act as positive reinforcement. Platform users could unlock different clothes, hairstyles, accessories, or pets, as a reward for completing lessons and progressing through the platform.

If you wanted people to get like motivated by the app we could like create like a point system, so like if they do a daily challenges or you know, do stuff, whereas like an app, they could get points and then get like new outfits for the avatar and like, you know, get new things and like maybe get a new background or something like that, or get a prize. To keep them motivated and keep using the app. (Children workshop)

Figure 7. Participant platform designs demonstrating a preference for customisation of platform features.

It was recognised that platform users would have different preferences and therefore they should be provided with options to tailor the platform accordingly, for example, options for the frequency of notifications, or the option to turn sounds on or off:

> *Yeah, it could be like optional like it might be annoying if you like go onto a question that automatically read aloud so … like a little sound bar that you can click on if you want it to say it aloud.* (Adolescent workshop)

It was also acknowledged by participants that different coping strategies may work for different people and that platform users should be able to choose activities they find useful:

> *… so say we have these three [coping strategies] up and it was like, well these aren't working for me; you could refresh it and it could give you like another five examples. And if one of them aren't working, refresh it again and try some different ones.* (Adolescent workshop)

The provision of options was evident in views on parental involvement in the platform (e.g., receiving feedback), particularly for adolescents. On the stamping sheet, parental guidance during assessments was favoured more by children (m = 2.67/5 [where 5 indicates greater importance], sd = 1.18, n = 15) compared to adolescents (m = 1.73/5, sd = 1.32, n = 22). Participants spoke about privacy and confidentiality, as well as different family dynamics. There was acknowledgment that some platform users may not have supportive relationships with their parents and therefore would not want to share information about their mental health with them. When probed further, most participants said that parent involvement should be optional, and that the platform should allow the end-user to decide whether they wanted their parents to receive feedback or not and in what situations.

> First participant: *Maybe give you like a share option at the end –*
>
> Second participant: *Yeah, give you an option, but like for some kids if it's like emotional trouble they're having at home with like their family or if they don't connect well with their family then they probably wouldn't want them to know.* (Adolescent workshop)
>
> *I personally would not like my parent to do it with me because I feel like I wouldn't be as honest because I like keeping what's happening like at school and stuff and*

> *what's happening at home separate. I don't really like talking about it that much. So, like I think there should definitely be the option that you can do it with your parents if you want to and feel more comfortable with, but I also know that a lot people would want to do it by themselves.* (Adolescent workshop)

Intuitive. Having a platform that is easy to use and simple to understand was important for participants. This was particularly evident when participants spoke about or drew navigation functions. A common theme across participants' artefacts was the use of different sections for different content (e.g., different emotions or mental health issues) or parts of the platform (e.g., games or sessions) (Figure 8). Participants visually and verbally communicated about the need to have links or tabs that platform users could click on to direct them to different sections. These tabs and links were often reflected in artefacts as a menu (Figure 8). Another function that participants recommended was a search bar so that platform users could easily find the information they were looking for. Participants wanted to access

Figure 8. Participant platform designs demonstrating a preference for simple and easy to use navigation functions.

resources and information quickly and therefore, having information that was simple and "to the point" was seen as important:

> *Easy to access, easy to search something up so you're not going through rabbit holes to try and where you want to go and it's not a confusing … difficult … where you get into the website, take one look and then go 'that looks a nightmare to get through'*. (Adolescent workshop)

> *It would be like really simple, like simple stuff you know on there, and also it would make it quick and breezy and simple, like you know, they wouldn't have to read a bunch of like things, it would just be super simple*. (Children workshop)

A "guide" character was one proposed way to facilitate navigation through the platform. While characters were seen to have multiple potential purposes including motivator and educator, character guides or helpers were more commonly referred to. Participants explained that these characters would lead them in their journey through the platform, provide instructions, and be available to provide help when needed. For example, in Figure 9, a child explained that the guide could provide step-by-step help throughout the website. While both children and adolescents rated having a character to guide them through assessment questions as desirable (m = 4.3/5, sd = 0.72, n = 15; m = 3.0/5, sd = 1.34, n = 23, respectively), this was ranked more favourably by children.

> *… I'm imagining the avatar would kind of like talk you through it be like – 'first, maybe carry out this and once you've done that you can go to this, this is the settings, this is how you can choose your background' – and like kind of instruct you through it. So that you have, like you know, what you need to do and what resources you have available*. (Adolescent workshop)

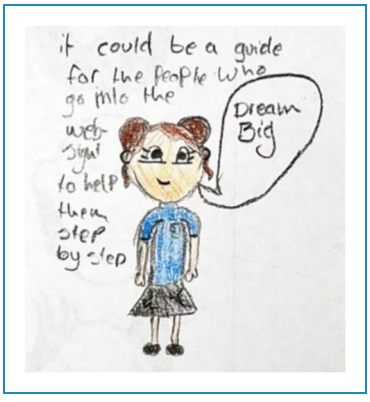

Figure 9. A child's platform design depicting a guide character.

> *If it was like the app, Siri or … 'hey Google'. It just helps you because like you ask it a question and it actually replies to you … Say you feel a bit lonely you can just go up to the app and say 'what game should I play?' and it gives you these three options out of your favourites and then like as you play you ask your avatar another like question … that'd be kind of nice because then even if your friends weren't playing the app with you, you'd still feel like someone's there with you."* (Children workshop)

Participants suggested that there should be a 'help' button, to access guidance and information quickly. Children often described getting help in relation to using the platform, for example, through the guide character. For adolescents, accessing help was more about the need to have easy and quick access to external resources and services such as the provision of contact details for psychologists or emergency services.

> *There would probably be a help button on the app, like, it would help you if you like were stuck with the app and it would help you in games and like when you were doing like your calendar it would like help you …* (Children workshop)

> First participant: *I think there should be an emergency button*.

> Second participant: *Yeah, like where you can call someone or something*.

> First participant: *Where you can call Kids Helpline, the police, the ambulance*.

> Second participant: *In case you actually, like need help*.

> First participant: *This could be like, one of the kid's only places to get help*. (Adolescent workshop)

Figure 10 provides example artefacts of help buttons. While the top two artefacts refer to help buttons for platform use, the bottom two show buttons for immediate help external to the platform.

Inclusive. Participants, particularly adolescents, communicated that it was important for the platform to appeal to a wide range of audiences with different needs and backgrounds, and that this inclusivity should be conveyed through both platform functionality and appearance. They expressed that minority populations should be included in graphics, character options, videos, and animations, to convey to platform users that the platform is inclusive of those who are gender and culturally diverse:

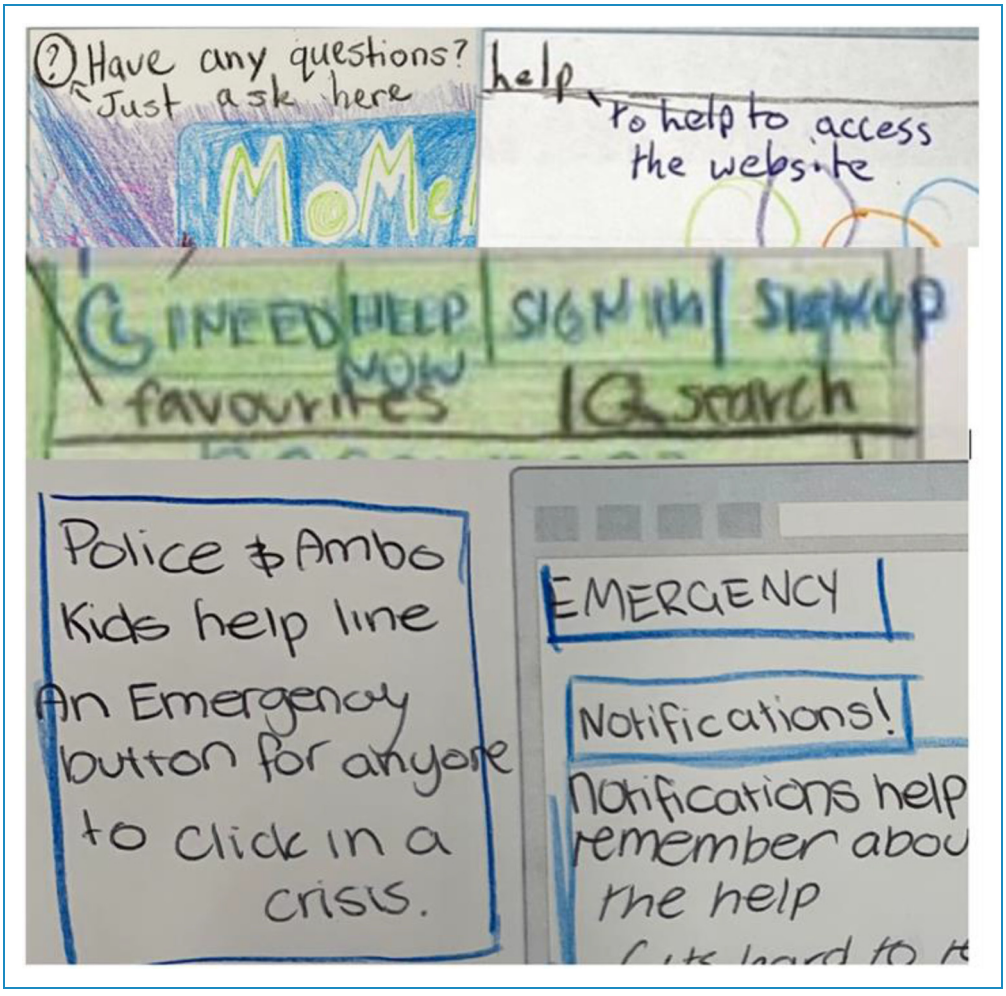

Figure 10. Participant platform designs incorporating help buttons.

First participant: *I think like very culturally diverse with the cartoons*.

Second participant: *Yeah, I think very inclusive of different communities*.

Third participant: *Yeah, especially people going on there for help, there will be people of different, I guess cultures*.

First participant: *Like having someone who's transgender or something*.

Second participant: *Yeah, or nonbinary, they identify as a he/she or they* (Adolescent workshop)

Say there's a person who wants to be transgender, but their parents aren't accepting at home, they could build their own avatar and express who they want to be through that. I guess they could create their own person. (Adolescent workshop)

Providing variations for the presentation of learning material was highlighted as important to cater for the learning preferences of platform users (e.g., written, audio, and/or video content). For example, Figure 11 shows an adolescent's design incorporating text and videos. As such, providing different options for how material was communicated would promote platform users' engagement with the platform:

… because everyone's different, like some people learn verbally, some people learn—like listening to things, like just like even a couple of options like even if it's like would you like to watch a video of someone explaining it or would you like to read, like this paragraph or something, or just things like that, and just have different options. (Adolescent workshop)

Specifically, participants highlighted the importance of flexible functionality, for example, having the option for information to be read aloud to the end-user. This

Figure 11. A adolescent's platform design incorporating text and videos.

would promote end-user choice as well as improve accessibility to those with specific learning needs. This function was noted as important for younger platform users whose reading skills have not yet developed. On the assessment worksheet, children were more likely to assign more value (stamps) (m = 3.92/5, sd = 1.38, n = 12) to the option of having questions read aloud during assessments, compared to adolescents (m = 2.43/5, sd = 1.33, n = 21).

> *Maybe you can hear it because maybe people don't want to read it or they can't read yet, they can just hear it and they understand oh I should go get my parent, because they might not understand that word or they might need glasses to read stuff or something. So, they just hear it.* (Children workshop)

> *Like some kids might have something like dyslexia or something so, you know, they need that [reading out loud] so like they know what they're reading so they don't answer the question wrong.* (Adolescent workshop)

Personalised, transparent and trustworthy content. Participants shared the desire for content, such as lessons and resources, to be personalised to the individual, as opposed to generic advice they could find on other websites.

> *… because one thing I hate is everything's really generic … when you talk to people, it's generalising everything, not specifically what's wrong.* (Adolescent workshop)

A suggestion put forth in adolescent workshops was that information should start off broad but as platform users engaged with the platform, answered questions, and searched for information, the content would become more specific to their needs. One way in which this could be achieved was through a recommendation engine that would direct them to useful information on the platform, help-seeking strategies and resources, as well as calming and coping strategies for general well-being, based off their use of the platform.

> *A little bit of a home page at the start so you can like scroll through and see like maybe a recommendation sort of thing based off things you've seen … like maybe if you looked at like some relaxation exercises and things, it would show you more of that.* (Adolescent workshop)

It was understood that in order for content to be personalised, the platform would need to ask platform users questions, yet participants expected that assessment questions should be responsive to their previous answers, creating as short of a path to the personalised content as possible.

> *… have the questions based on the previous results become more suited to you. So not just answering questions that aren't related to you.* (Adolescent workshop)

As part of expediting this process, they thought that content should present a summary first, making it easier for platform users to decide if the content is applicable to them or not.

> *So, you don't want to have to look through this whole big text, right, with multiple paragraphs, and then it's like not what you're looking for. So, if you have like dot points at the start … like giving a summary about, like a context, contents part where you can go to like, click on this paragraph if you need this, I don't know, just you know it's like the right information, you're not reading like stuff you don't need help with …* (Adolescent workshop)

To give the platform users greater control over this process, they express a desire to save and/or 'favourite' items that they find particularly relevant to them.

> *I would probably let someone save what they really like and then they can go back and say well I really like this, could you add more of it and then when they go back, when it's in favourites, then your added stuff is in your favourites.* (Children workshop)

It was also important to participants (mostly adolescents) for the platform to be transparent and trustworthy. Platform users should know where content comes from and the purpose of assessment questions and platform activities. On the stamping sheet, participants placed value on knowing what assessment questions will be used for (children m = 3.19/5, sd = 1.33, n = 16; adolescent m = 3.48/5, sd = 1.34, n = 23).

> *So, they can have like a little box where you could press it, and then fill out the question, and it will tell you the meaning of why we asked you that question.* (Children workshop)

Another suggested way that transparency could be achieved in assessments was to let platform users know how many questions there were to answer, and how far along they were in the assessment. On the stamping sheets, both children and adolescents placed value on having an assessment progress bar (m = 3.83/5, sd = 1.19, n = 12; m = 3.52/5, sd = 1.04, n = 23, respectively).

> *Like make sure we know like how many questions there are, and how far through you are.* (Adolescent workshop)

Participants noted that it is particularly important for platform users to know enough about a platform before being required to provide their personal details through a registration process. This included knowing that the platform was associated with trustworthy organisations such as schools, governments and/or universities. For example, one child listed trust as one of the key components of their website design, alongside help and positivity (Figure 12).

> *… like if you're worried about privacy or something, you'd be like 'oh it's a university'… like if I see like a .gov or .edu or like a university symbol that I know of then it kind of makes me feel like the stuff … in the website's reliable.* (Adolescent workshop)

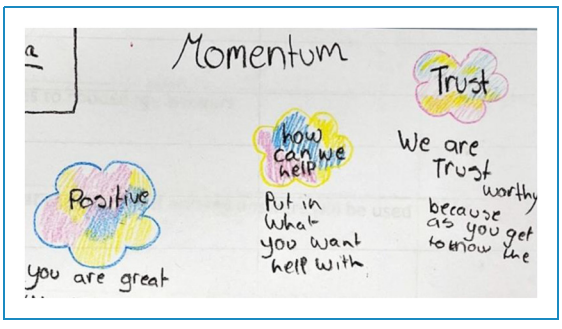

Figure 12. A child's platform design demonstrating the important of trust.

> *Yeah, you can say this website is trustworthy, like maybe if you scroll down to like the end of it or something and said this website is trustworthy and other kids have used it and … say that people have used it and it's, what's the word? It's, like it's safe. It's not going to go into any details, like your details about everything, like addresses or anything.* (Children workshop)

Differences between adolescent and child responses

While there was consensus across the participant sample regarding overarching features of the platform, e.g., easy navigation system and interactive elements, there were also some noticeable differences between the two participant groups. Compared to adolescents, child participants spoke more about the use of colours to represent emotions, customisation as a form of positive reinforcement (e.g., rewards), interactive games, and avatars and characters facilitating relatability in the platform. Comparatively, concepts that were unique to adolescent responses included normalisation of mental health issues, the use of testimonies to reduce stigma, incorporation of a social chat function, and having information tailored to the end-user via a recommendation engine.

Post-workshop survey

Forty-seven participants (69%) completed the post-workshop survey. Most participants (61.7%) rated the workshop as "very good" on a 5-point scale, followed by "Good" (34.0%) and "Neutral" (4.3%). The majority of participants felt that they could take part in activities, talk about their thoughts and feelings and contribute to the platform. Most participants also reported learning something new during the workshops and felt that their thoughts and ideas would be listened to (Table 3).

Discussion

This research addressed a major barrier to DMHI engagement; a lack of collaboration with young people in DMHI design, particularly for those under the age of 12.[35] By partnering with young people in the design of a new digital mental health platform (Momentum), we seek to improve young peoples' engagement with DMHIs, acceptance of DMHIs as a valuable model of care, and adherence to mental health treatment, by developing a platform that end-users find engaging, motivating, and helpful.

Principal results

In investigating young people's preferences for the 'look and feel' of Momentum (research question 1), their perceptions on how the platform should function (research

Table 3. Co-design post-workshop survey.

Statement	Yes, agree n (%)	No, disagree n (%)	Not sure n (%)
I could take part in the activities as much as I wanted to	44 (93.6)	0 (0)	3 (6.4)
I felt that I could talk about my thoughts and ideas	44 (93.6)	0 (0)	3 (6.4)
I felt that I would be listened to if I talked about my thoughts and ideas	44 (93.6)	0 (0)	3 (6.4)
I was able to contribute to ideas and decisions for the new digital platform	43 (91.5)	0 (0)	4 (8.5%)
The researchers will listen to my thoughts and ideas when making the new digital platform	37 (78.7)	0 (0)	10 (21.3)
I learned something new at the workshop[a]	32 (69.6)	4 (8.7)	10 (21.7)

[a]One missing response.

question 2) and their opinions on what would make the platform engaging (research question 3), we found that participants wanted a digital mental health platform that was interactive, relatable, customisable, intuitive, and inclusive, and that had personalised, transparent and trustworthy content. We structured co-design workshops by age and categorised them as either 'child' or 'adolescent' workshops to compare responses between the two groups. Our findings confirmed that two platform versions, one tailored to children and one tailored to adolescents, were appropriate and necessary. For example, many participants wanted characters and videos to reflect people similar to their age to enhance relatability with the platform. Furthermore, the study findings revealed some differences in the preferences and design ideas of the different age groups, such as adolescents' suggestion for a recommendation engine to tailor treatment content, and children's preference for customisation of platform features as a form of positive reinforcement. Previous research has found that DMHIs that are "juvenile" or tailored towards younger children are described as "off-putting" by adolescents.[33] By co-designing two versions of the platform for different age groups, we aim to overcome this barrier to engagement.

Children and adolescents have largely been excluded from the design of DMHIs in the past.[35] Our research addressed this problem by demonstrating that young people can make valuable contributions to DMHI design. Our participants provided unique insights into their preferences, needs, experiences and circumstances, and created visual designs of the new platform, which would have not been accessible without including them as partners in the design process. This genuine contribution was reflected in participants' strong engagement in verbal discussions and the production of rich artefacts. The post-workshop survey results revealed that children and adolescents recognised their meaningful contribution, with most participants agreeing that research team would listen to their thoughts and ideas when building the platform, and that they were able to contribute to ideas and decisions for the platform.

Comparison with prior work

Previous research has found that young people perceive DMHIs to be fun and engaging when they are interactive or have a "game-like" feel.[33,51] Our research builds on these findings by establishing three purposes for interactive activities in youth DMHIs: 1) to aid the learning and retention of treatment content, 2) to help calm end-users, including breaks for relaxation and 3) to reward end-users for their engagement with the DMHI. Having a DMHI that young people find relatable is another facilitator of user engagement conveyed by our participants, and reported by previous literature.[30,33] Participants in our study communicated the following strategies for enhancing relatability: use of non-judgmental language and age-appropriate terminology; the inclusion of intervention characters, avatars and situations that end-users can identify with; normalisation of end-users' experiences; and features that allow personalisation of DMHIs. Liverpool et al.'s systematic review of DMHI engagement recommended that children and young people's engagement with DMHIs could be enhanced by allowing end-users to personalise a profile, set personalised goals, and have personal health tracking features.[26]

Borghouts et al. refer to relatability facilitators as "perceived fit" which is "the extent to which users felt the intervention was appropriate and relevant to their culture and values and/or targeted to people similar to them, rather than a one-size-fits-all solution"[30(p11)]. We found limited evidence in the literature of young people's preference for diverse cultural and gender representations in DMHIs or a desire for DMHIs to recognise different learning needs (i.e., dyslexia), indicating this finding is novel to our research, and may reflect current education that young people are receiving about gender and cultural diversity, and specific learning needs.

Related to the concept of perceived fit is customisation.[30] Achilles et al. argued that customisation enables young people to have ownership and agency over their

treatment[36] and Gardio et al.'s systematic review of digital mental health interventions for depression and anxiety in young people identified a lack of customisation as a "disliked" feature of DMHIs.[33] Our research found that customisation could be enhanced via features that could be changed by end-users (e.g., backgrounds and themes), offering options throughout the platform (e.g., level of parental involvement and frequency of notifications), and offering customisation of features as a positive reinforcement (i.e., rewards) for using the platform (e.g., unlocking new activities).

Young people have reported valuing DMHIs that are easy to navigate, use and understand.[33] Participants in our study designed platform features such navigation bars, menus, tabs hyperlinks, search bars and characters to make the new digital platform intuitive to use. Other features recommended to enhance DMHI engagement and treatment adherence by participants in our research and the research of others[26,36,51] include tailored content, concise information, and transparent and trustworthy information that supports credibility. In particular, content and information that is personalised for end-users was deemed important. While uncertainty about the evidence-base and credibility of DMHIs has been established as a barrier to user engagement in adult populations (>16 year-olds),[30] our research demonstrates that this preference is also evident in younger populations (7–17 year-olds).

Recommendations

From the findings of this study, we make several recommendations for the design, functionality and content of youth DMHIs (Box 1), as well as three recommendations for researchers and clinicians conducting co-design and intervention development research with children and adolescents. Supplementary File 2 provides example prototypes, demonstrating how Momentum has incorporated these recommendations.

Box 1. Recommendations for the design, functionality, and content of DMHIs.

1. Build features into the intervention that encourages platform users to *interact* with content and treatment, for examples: games, videos, interactive characters, tracking features (emotional check-ins, diaries), quizzes, rewards, and chat boxes.
2. Enhance the *relatability* of the intervention by involving platform users in the design process; including characters that reflect and represent platform users (e.g., age); normalising mental health; using non-pathologizing language; using colours as representative symbols (e.g., for emotions); including user testimonies; and using relatable scenarios to model skills.
3. Create *customisable* features (e.g., backgrounds and avatars) to allow platform users to have ownership of their program, and provide intervention options, for example, turning sounds on and off and selecting the frequency of notifications.
4. Ensure that the program is *intuitive*, i.e., is it easy to use and understand. This can be achieved through age-appropriate terminology; navigation bars, menus, tabs and hyperlinks; a search bar; summarised content or resources; and a guide character that helps the end-user throughout the platform.
5. Facilitate *inclusivity* of the platform by including gender and culturally diverse characters, providing a variety of materials that cater to different learning and reading needs (e.g., text, audio and videos), and allowing flexible functionality (e.g., read-aloud options).
6. Design content that is:
   (a) Personalised (e.g., treatment and resources that are tailored to individuals' needs).
   (b) *Transparent* (e.g., explain how platform users' responses will be used, why platform users are asked to complete surveys or tasks, and how content was developed).
   (c) *Trustworthy* (e.g., interventions are designed in partnership with credible organisations such as universities, schools and governments).
7. Consider the needs and preferences of different age groups, by adapting content, terminology and features. In some instances, it may be appropriate to create different versions of the intervention for different age groups that incorporate these adaptations.

Recommendations for conducting co-design and intervention development research with children and adolescents

Recommendation 1: Collaborate with end-users as partners in codesign. We recommend that clinicians and researchers engage in partnership with children and adolescents in the co-design of DMHIs, where young people are encouraged to have ownership over their designs. This partnership can be achieved by establishing rapport with young people early in the research, for example, by playing icebreaker games, explaining why their opinions are important, and being transparent about how their ideas and designs are going to be used. Encouraging young people to be co-design partners, rather than informants, can be further achieved by initially minimising any design parameters. A blank slate approach (e.g., asking participants to produce design artefacts [drawings and/or notes] with minimal instructions) reduces researcher influence. This approach also allows young people to direct the design of DMHIs and workshop discussion, for example, the researcher or clinician can build on participants' naturally occurring designs and ideas by asking questions about certain elements.

Recommendation 2: Utilise diverse data collection methods when working with children and adolescents.

Researchers and clinicians should incorporate a variety of data collection methods and design tools in co-design. For example, in our research, we used a generative toolbox containing drawing tools, stamp sheets, templates, and worksheets, which were paired with verbal discussions. Other examples of co-design tools and activities suitable for young people include post-it notes, mapping activities, brainstorm clouds, whiteboards, games, card sorting and storytelling.[38,42] Using a variety of methods allows children of all ages, with different cognitive and physical abilities, and communication preferences, to provide meaningful input to the design of DMHIs. This approach ensures that young people have a fair and equal opportunity to contribute to the design of DMHIs as they can chose from different mediums to express themselves, for example, some children may not like speaking in front of others, preferring to draw or write. Using a variety of methods also allows for triangulation of data,[52] providing a more comprehensive understanding of young people's needs and preferences for a digital mental health platform. For example, in our research, verbal discussions helped the research team understand young people's visual designs (e.g., the purpose of a button, or how a game worked) and vice versa (e.g., visual representations helped explain ideas that were difficult for young people to articulate). Researchers and clinicians should consider how different data collection methods can complement each other to achieve a shared understanding of young people's design ideas.

Recommendation 3: Structure co-design workshops based on participants' age. It is recommended that separate co-design workshops are conducted for different age groups. Structuring workshops by age of participants fosters an environment where participants are more likely to be matched on their comprehension and language abilities and psychosocial characteristics.[53] It may also reduce power imbalances between younger and older participants. Further, we found that this approach promotes an expression of shared experiences and understanding, where participants of similar ages could relate to each other, for example, discussions about using the same digital programs in school. Comparing data across age-specific workshops will confirm the need for multiple age-appropriate interventions, or whether a single intervention is appropriate across age groups.

Strengths and limitations

The strength of this research lies in its human-centred design approach in which the research team partnered with potential end-users (children, adolescents) in co-design. Specifically, we used methods that were well suited to children and adolescents (e.g., drawing and using ink stamps), and that allowed individuals with varying levels of cognitive and communication development to participate. While co-design methodology is anticipated to enhance end-user engagement with DMHIs, it is an assumption that this approach results in greater completion of intervention content or better clinical outcomes, and therefore, future research is needed to empirically assess this supposition.

Workshop participants were provided with a 'blank slate' to design the platform with minimal instructions. While participants were asked about certain topics (e.g., rewards, assessments), researcher influence was reduced by building discussions around participants' designs, asking broad open-ended questions, and allowing for flexibility in workshops. A black slate approach was also found to have potential drawbacks. Although more than 75% of participants reported using digital health or mental health apps, participants' ideas were at times more relevant to informational websites or games rather than treatment delivery, suggesting a lack of familiarity with treatment platforms. This limitation could be addressed by providing initial information about treatment platforms specifically, or recruiting participants who had experience using treatment platforms.

Due to the flexible nature of the workshops, some participants did not complete some of the workshop activities, for example, assessment stamping sheets and post-workshop surveys, or chose not to answer specific questions. Therefore, this data does not represent the entire study sample. The number of participants completing the assessment stamping activity and post-workshop surveys has been provided in the relevant sections.

The study sample was diverse in terms of ages, gender, and reported emotional difficulties. However, there was a gender imbalance in the adolescent workshops towards females. It is not known whether having a more balanced sample in terms of gender would have introduced different or novel design ideas and preferences. Though the majority of the sample endorsed previous experience of emotional and behavioural difficulties, we did not corroborate type or severity of difficulties. While we did not collect data on severity of difficulties or formal diagnoses, we did involve adolescents from a special assistant school that supported adolescents facing mental health challenges, and recruited participants via our partner, Kids Helpline. We recommend that future research actively recruit participant samples across the mental health spectrum through peak mental health organisations and clinics. To ensure a diverse sample, researchers could include self-report measures of mental health.

While we attempted to capture demographic data on ethnicity, socioeconomic status and language, there was missing data. It is likely that our sample was predominantly from higher socio-economic backgrounds with English as their first language. Future research could enhance diversity in their participant sample by recruiting young people through community groups, health and mental services, and organisations working with minority populations, for

example, culturally and linguistically diverse groups. Due to the nature of the workshops, we were unable to identify individual participants in transcripts, therefore, we could not compare responses between participant characteristics such as gender or self-reported emotional difficulties. Further research is needed to investigate the impacts of culture, language, socio-economic status, gender, and severity of emotional difficulties on young people's preferences and ideas for DMHIs.

Translating knowledge into practice

The findings from the co-design workshops, including young people's designs, have informed the development of prototypes of Momentum created by the research team in collaboration with web-designers (Supplementary File 2). Through an iterative process, children and adolescents provided feedback on the prototypes via a series of interactive workshops and surveys; informing Momentum's development in line with young people's preferences. The first iteration of the platform will attempt to incorporate as many participant ideas as is feasible, with further iterations being refined to incorporate additional features and functions suggested by participants. Usability testing with young people using think-aloud methods will then occur to provide further feedback on Momentum's functionality. The research project will produce an integrated, scalable, population-level model of digital mental health care provision for Australian youth. Momentum will be evaluated via a series of randomised control trials to assess its effectiveness in reducing mental health symptoms, cost effectiveness, and user adherence to treatment.

Conclusions

DMHIs present an opportunity for providing treatment to young people that overcomes barriers of access, cost and stigma. Despite these benefits, DMHIs are under-utilised, and treatment adherence has been found to be low. One of the core reasons proposed for young people's poor engagement with DMHIs is the lack of involvement of potential end-users in their design. This study aimed to co-design a digital youth mental health platform for anxiety, depression and other emotional issues, with young people aged 7–17 years. Specifically, we sought young peoples' preferences for the 'look and feel', functionality and engagement strategies of a new digital mental health platform. Six themes were identified: 1) Interactive, 2) Relatable, 3) Customisable, 4) Intuitive, 5) Inclusive, and 6) Personalised, transparent and trustworthy content. Building on these themes, we devised a set of seven recommendations, supported by end-user-designed strategies, for the design, functionality, and content of DMHIs. Further, we recommend that clinicians and researchers planning to conduct co-design and intervention development research with children and adolescents should collaborate with end-users as partners, utilise diverse data collection methods, and structure co-design activities based on participants' ages. The findings from this research will be used to create and evaluate a new digital youth mental health platform that aims to facilitate young people's DMHI engagement and treatment adherence.

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Declarations:

Conflicting interests: The Authors declare that there is no conflict of interest.

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Note

1. The term "website" was used in place of "platform" during workshops as this is a term children and adolescents are familiar with.

References

1. Polanczyk GV, Salum GA, Sugaya LS, et al. Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *J Child Psychol Psychiatry* 2015; 56: 345–365. 2015/02/05.
2. Lawrence D, Hafekost J, Johnson SE, et al. Key findings from the second Australian child and adolescent survey of

mental health and wellbeing. *Aust N Z J Psychiatry* 2016; 50: 876–886.
3. Finning K, Ukoumunne OC, Ford T, et al. The association between child and adolescent depression and poor attendance at school: A systematic review and meta-analysis. *J Affect Disord* 2019; 245: 928–938. 2019/02/01.
4. Rubens SL, Evans SC, Becker SP, et al. Self-reported time in bed and sleep quality in association with internalizing and externalizing symptoms in school-age youth. *Child Psychiatry Hum Dev* 2017; 48: 455–467. 2016/07/23.
5. Loevaas MES, Sund AM, Patras J, et al. Emotion regulation and its relation to symptoms of anxiety and depression in children aged 8-12 years: does parental gender play a differentiating role? *BMC Psychol* 2018; 6: 42. 2018/08/22.
6. Asselmann E, Wittchen HU, Lieb R, et al. Sociodemographic, clinical, and functional long-term outcomes in adolescents and young adults with mental disorders. *Acta Psychiatr Scand* 2018; 137: 6–17. 2017/09/02.
7. Copeland WE, Adair CE, Smetanin P, et al. Diagnostic transitions from childhood to adolescence to early adulthood. *J Child Psychol Psychiatry* 2013; 54: 791–799. 2013/03/05.
8. Johnson D, Dupuis G, Piche J, et al. Adult mental health outcomes of adolescent depression: A systematic review. *Depress Anxiety* 2018; 35: 700–716. 2018/06/08.
9. Council of Australian Governments. *National Action Plan on Mental Health 2006-2011*. Australia: Council of Australian Governments, 2006.
10. Jorm AF. The quality gap in mental health treatment in Australia. *Aust N Z J Psychiatry* 2015; 49: 934–935. 2015/09/13.
11. *Headspace*. *Increasing demand in youth mental health: A rising tide of need*. Australia: Headspace, 2019.
12. World Health Organization. *Mental Health and COVID-19: Early evidence of the pandemic's impact: Scientific brief, 2 March 2022*. Geneva, Switzerland: WHO, 2022.
13. OECD. *Tackling the mental health impact of the COVID-19 crisis: An integrated, whole-of-society response*. Paris, France: OECD, 2021.
14. Duden GS, Gersdorf S and Stengler K. Global impact of the COVID-19 pandemic on mental health services: A systematic review. *J Psychiatr Res* 2022; 154: 354–377. 2022/09/03.
15. McDonnell D, Vasiliou VS, Lonergan E, et al. Psychologists' experiences who managed waitlists in mental-health services during the COVID-19 lockdown: A mixed-method study. *EJPO* 2022; 81: 47–56.
16. Australian Psychological Society. *1 in 3 psychologists are unable to see new clients, but Australians need help more than ever*. Melbourne, VIC, Australia: Australian Psychological Society, 2022. https://psychology.org.au/for-members/news-and-updates/news/2022/australians-need-psychological-help-more-than-ever.
17. Radez J, Reardon T, Creswell C, et al. Adolescents' perceived barriers and facilitators to seeking and accessing professional help for anxiety and depressive disorders: A qualitative interview study. *Eur Child Adolesc Psychiatry* 2022; 31: 891–907. 2021/01/28.
18. Anderson JK, Howarth E, Vainre M, et al. A scoping literature review of service-level barriers for access and engagement with mental health services for children and young people. *Child Youth Serv Rev* 2017; 77: 164–176.
19. Roberts M, Jones J, Garcia L, et al. Adolescents' perceptions of barriers and facilitators to engaging in mental health treatment: A qualitative meta-synthesis. *J Child Adolesc Psychiatr Nurs* 2022; 35: 113–125. 2021/10/06.
20. Pennant ME, Loucas CE, Whittington C, et al. Computerised therapies for anxiety and depression in children and young people: A systematic review and meta-analysis. *Behav Res Ther* 2015; 67: 1–18.
21. Hollis C, Falconer CJ, Martin JL, et al. Annual research review: digital health interventions for children and young people with mental health problems-a systematic and meta-review. *J Child Psychol Psychiatry* 2017; 58: 474–503.
22. Khanna MS and Carper M. Digital mental health interventions for child and adolescent anxiety. *Cogn Behav Pract* 2022; 29: 60–68.
23. Pretorius C, Chambers D, Cowan B, et al. Young people seeking help online for mental health: cross-sectional survey study. *JMIR Ment Health* 2019; 6: e13524–e13524.
24. March S, Donovan CL, Baldwin S, et al. Using stepped-care approaches within internet-based interventions for youth anxiety: three case studies. *Internet Interv* 2019; 18: 100281.
25. Weineland S, Ribbegårdh R, Kivi M, et al. Transitioning from face-to-face treatment to iCBT for youths in primary care – therapists' attitudes and experiences. *Internet Interv* 2020; 22: 100356.
26. Liverpool S, Mota CP, Sales CMD, et al. Engaging children and young people in digital mental health interventions: systematic review of modes of delivery, facilitators, and barriers. *J Med Internet Res* 2020; 22: e16317. Review 23.6.2020.
27. Donovan CL and March S. Online CBT for preschool anxiety disorders: a randomised control trial. *Behav Res Ther* 2014; 58: 24–35. 2014/06/14.
28. Spence SH, Donovan CL, March S, et al. A randomized controlled trial of online versus clinic-based CBT for adolescent anxiety. *J Consult Clin Psychol* 2011; 79: 629–642.
29. Clarke AM, Kuosmanen T and Barry MM. A systematic review of online youth mental health promotion and prevention interventions. *J Youth Adolesc* 2015; 44: 90–113.
30. Borghouts J, Eikey E, Mark G, et al. Barriers to and facilitators of user engagement with digital mental health interventions: systematic review. *J Med Internet Res* 2021; 23: e24387.
31. Lehtimaki S, Martic J, Wahl B, et al. Evidence on digital mental health interventions for adolescents and young people: systematic overview. *JMIR Ment Health* 2021; 8: e25847. Review 29.4.2021.
32. Bergin AD, Vallejos EP, Davies EB, et al. Preventive digital mental health interventions for children and young people: A review of the design and reporting of research. *NPJ Digit Med* 2020; 3: 133.
33. Garrido S, Millington C, Cheers D, et al. What works and what doesn't work? A systematic review of digital mental health interventions for depression and anxiety in young people. *Front Psychiatry* 2019; 10: 759–759.
34. Grist R, Croker A, Denne M, et al. Technology delivered interventions for depression and anxiety in children and adolescents: A systematic review and meta-analysis. *Clin Child Fam Psychol Rev* 2019; 22: 147–171. 2018/09/20.
35. Jones R B, Stallard P, Agha SS, et al. Practitioner review: co-design of digital mental health technologies with children and young people. *J Child Psychol Psychiatry* 2020; 61: 928–940.

36. Achilles MR, Anderson M, Li SH, et al. Adherence to e-mental health among youth: considerations for intervention development and research design. *Digit Health* 2020; 6: 2055207620926064.
37. Slattery P, Saeri AK and Bragge P. Research co-design in health: A rapid overview of reviews. *Health Res Policy Syst* 2020; 18: 17.
38. Thabrew H, Fleming T, Hetrick S, et al. Co-design of ehealth interventions with children and young people. *Front Psychiatry* 2018; 9: 481. 2018/11/09.
39. Bird M, McGillion M, Chambers EM, et al. A generative co-design framework for healthcare innovation: development and application of an end-user engagement framework. *Res Involv Engagem* 2021; 7: 12.
40. Moullin JC, Dickson KS, Stadnick NA, et al. Ten recommendations for using implementation frameworks in research and practice. *Imp Sci Comms* 2020; 1: 42.
41. Jolles M P, Willging CE, Stadnick NA, et al. Understanding implementation research collaborations from a co-creation lens: Recommendations for a path forward. *Front Health Serv* 2022; 2. 2022/01/01. doi: 10.3389/frhs.2022.942658.
42. Nakarada-Kordic I, Hayes N, Reay SD, et al. Co-designing for mental health: creative methods to engage young people experiencing psychosis. *Design Health* 2017; 1: 229–244.
43. Steen M, Manschot M and Koning ND. Benefits of co-design in service design projects. *Int J Des* 2011; 5: 53–60. Benefits, Co-Design, Service Design, Cases.
44. Sanders EB-N, Brandt E and Binder T. A framework for organizing the tools and techniques of participatory design. In Proceedings of the 11th Biennial Participatory Design Conference. Sydney, Australia: Association for Computing Machinery, 2010, p. 195–198.
45. Bratteteig T, Bødker K, Dittrich Y, et al. Methods: organising principles and general guidelines for participatory design projects. In: Simonsen Jesper and Robertson Toni (eds) *Routledge international handbook of participatory design*. New York, NY: Routledge International, 2013, pp. 117–144.
46. Kensing F and Greenbaum J. Heritage: having a say. In: Simonsen Jesper and Roberton Toni (eds) *Routledge international handbook of participatory design*. New York, NY: Routledge, 2013.
47. Sanders EBN and Stappers PJ. Probes, toolkits and prototypes: three approaches to making in codesigning. *CoDes* 2014; 10: 5–14.
48. Gale NK, Heath G, Cameron E, et al. Using the Framework Method for the analysis of qualitative data in multi-disciplinary health research. *BMC Medical Res Methodol* 2013; 13: 117.
49. Guba EG and Lincoln YS. Competing paradigms in qualitative research. In: Denzin NK and Lincoln YS (eds) *Handbook of qualitative research*. Thousand Oaks, CA: Sage Publications, Inc., 1994, pp. 105–117.
50. Korstjens I and Moser A. Series: practical guidance to qualitative research. Part 4: trustworthiness and publishing. *Eur J Gen Pract* 2018; 24: 120–124. 2017/12/06.
51. Grist R, Porter J and Stallard P. Mental health mobile apps for preadolescents and adolescents: A systematic review. *J Med Internet Res* 2017; 19: e176. Review 25.05.2017.
52. Carter N, Bryant-Lukosius D, DiCenso A, et al. The use of triangulation in qualitative research. *Oncol Nurs Forum* 2014; 41: 545–547. 2014/08/28.
53. Adler K, Salanterä S and Zumstein-Shaha M. Focus group interviews in child, youth, and parent research: An integrative literature review. *Int J Qual Methods* 2019; 18: 1609406919887274.