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Co-designing an online educational resource to help adolescents improve their digital health literacy

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Abstract

Background Digital media is ubiquitous in adolescents' lives and provides many opportunities to engage with health information. However, there is an increased risk of engaging with inaccurate or biased health information on the internet, resulting in poor health-related behaviours. As such, adolescents would benefit from improving their digital health literacy (DHL). There are limited education tools in DHL that are interactive and relatable for adolescents. A co-design approach can incorporate adolescents' perspectives in designing an education tool to ensure its relevance.

Aims This study aimed to determine the effectiveness of the co-design approach in creating an educational resource designed to improve adolescents' DHL.

Methods Three workshops were conducted with adolescents (12–17 years) to explore their DHL habits and education needs, evaluate an existing DHL educational app, co-design new storylines to better meet their needs and beta test the expanded resource. Data was collected through creation of storyboards, annotated posters and worksheets. Data analysis of these artefacts was undertaken through content analysis to identify themes and sub-themes.

Results Forty-four participants attended two co-design workshops. Participants preferred using video-based social media and considered using artificial intelligence (AI) tools for extracting online health information. They designed storylines involving health topics such as dietary supplements, fitness and mental health. Storylines focused on identifying trustworthy online health information sources and dealing with concerns regarding scams, social media influencers and misinformation conveyed by parents. Eight participants who attended the beta-testing workshop positively evaluated the app as engaging and relatable.

Discussion This study clarified the DHL educational needs of adolescents. In particular, it demonstrated the need to include other media literacies, the use of AI tools and interactions with family in the resource to maximise relevance to adolescents.

Conclusion The co-design methodology was useful for understanding adolescents' DHL lived experiences and developing an engaging educational resource to help them navigate and appraise online health information.

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Introduction

Adolescence is a key period of rapid cognitive and psychosocial development for young people. At this stage of life, the acquisition of information, skills and behaviours needed for adulthood is critical in facilitating independence and lifelong health and wellbeing [1]. With their increasing autonomy, adolescents also begin to engage with the health system independently from their parents [1]. Digital media is nowadays ubiquitous in the lives of adolescents and provides many opportunities to engage with health information and support networks to guide health-related behaviours [2, 3]. However, there is a high risk of engaging with inaccurate or biased health information that is prevalent on the internet via social media and other online avenues [4]. Due to adolescents' relative inexperience with health information, this online misinformation could render them vulnerable to adopting risky health-related behaviours that negatively affect their health and wellbeing. This misinformation could also contribute to poor health attitudes and behaviours that continue into adulthood and could lead to negative health outcomes.

Despite regularly using the internet to explore health concerns, adolescents display varying levels of distrust and scepticism when accessing health information online. Adolescents are aware that there are vast amounts of unmoderated and unreliable health content, and they are often distressed when they discover inaccurate and inconsistent information [5, 6]. This apprehension towards online health information has the potential to contribute to health-related anxiety and poor health decisions, thus augmenting negative health outcomes [5, 7]. Despite this, adolescents often rate their ability to navigate online health information higher than they actually can [8]. This is often due to relying on rote-learnt heuristics, such as over-reliance on certain URL domains, to appraise online health information [8]. When prompted to elaborate on their search process and appraisal methods for health-related websites, most adolescents are unable to sufficiently explain their reasoning [8, 9]. This indicates a significant knowledge gap in adolescents' online health information use that requires addressing from educators and health professionals.

To effectively navigate and apply online health information, adolescents need support to develop their digital health literacy, that is, the ability to seek, find, understand and evaluate health information from electronic sources and apply the knowledge gained to solve a health problem [10]. Current educational resources on digital health literacy for adolescents mainly consist of face-to-face teaching sessions or online courses [11]. These resources tend to be didactic in form, which can raise issues regarding accessibility, relevance and engagement. Furthermore, many of these educational resources are not developed with the active participation of young people and may lack relevance to the digital landscape to which they are often exposed [11]. Therefore, there is an undersupply of education tools for developing digital health literacy that are interactive, self-directed and relatable for adolescents.

A useful framework for understanding effective ways of educating adolescents is Social Cognitive Theory. This theory considers that an individual's learning is influenced by a dynamic interaction of personal, environmental and behavioural factors [12]. The theory also contends that increasing self-efficacy in solving problems is key to ensuring good skill development and that young people are more engaged in the learning process if the outcomes are tangible, relevant and important to them [13]. As such, it is important to develop educational interventions that are interactive and engaging through the active involvement and self-reflection of the adolescent end user, which will enhance self-efficacy and aid in learning [14].

A co-design approach [15] presents a valuable methodology through which to incorporate adolescents into the design process for an educational resource that prioritises their perspectives and lived experiences, promotes their agency and teaches a wide and diverse range of young people how to identify trustworthy information on the internet [16]. Co-design workshops have been shown to be useful in designing adolescent health interventions because they assist in creating a shared language between adult researchers and adolescent stakeholders, and help to establish a mutual learning environment [17, 18]. Co-design approaches can also utilise creative techniques, such as visual materials and storytelling, to create a fun, playful, interactive environment for research and data collection, which can help remove the potential awkwardness and anxiety experienced by young people when discussing their experiences in traditional research settings [19, 20]. However, co-design approaches in development of educational resources are primarily evaluated early in the research process, with little appraisal of the resource beyond the initial design stage [21, 22].

This study explores using the co-design methodology to further expand upon a previously developed educational resource; the educational app 'mis-Adventures' ™. This app was designed and created in an earlier co-design process [14] with adolescent participants. It utilises an

interactive 'problem-solving and decision-making'-style interface to direct users through a range of digital health literacy scenarios, which are designed to educate adolescents about finding and appraising online health information. By adding more storylines to the app through an additional co-design process, there is the potential to further create a more relevant and contemporary educational resource for adolescents. The aim of this study is to determine the effectiveness of the co-design approach as a research methodology in creating an accessible and relatable educational resource designed to improve adolescents' digital health literacy. The study will also explore the research question: How effectively does the educational resource address co-design workshop participants' lived experiences and digital health literacy education needs?

Methods

This study utilised a co-design framework [15] involving three workshops with adolescent participants to further develop the educational resource "mis-Adventures' "to improve adolescents" digital health literacy and undertake a preliminary evaluation through beta testing.

Context

Of the three workshops, the first two were co-design workshops, which were conducted to devise two new digital health literacy storylines for the "mis-Adventures "educational app based on adolescents" experiences with online health information. This was to further expand the complexity and breadth of the storylines on the app. Once the two new storylines had been developed, a third workshop was conducted with a subset of the initial workshop participants to undertake a preliminary evaluation of the new storylines through beta testing. Workshops were facilitated by the research team and software developers.

Co-design workshops

Adolescent participants attended one of two in-person two-hour co-design workshops in November 2023. These workshops investigated adolescents' digital health literacy needs and explored scenarios where adolescents find and appraise online health information. The co-design workshops began with an icebreaker activity where participants annotated posters containing common search engines and social media platforms to indicate which they have an account with, which they use regularly, which they use to intentionally search for health information and which they would consider using for health information in the future. Participants were also given the opportunity to add posters with additional websites and social media for others to annotate. The second activity involved completing a previously developed storyline on the "mis-Adventures' " app. Participants commented on worksheets to evaluate the existing storylines and app design features. The final activity involved creation of storyboards featuring both text and images depicting storylines about navigating online health information within small groups of two or three participants. Groups placed their creations on a wall and presented them to workshop participants and facilitators. Participants annotated the designs to indicate their preferred storylines. An initial content analysis of the storyboards by researchers and software developers informed the creation of the two new digital storylines for the app.

Preliminary evaluation

Participants beta tested the two new digital storylines in an in-person one-hour workshop in June 2024 to investigate their appeal to young users. After completing the storylines, participants filled out a worksheet containing question prompts to capture perspectives on how well the storylines explored the ideas mentioned during the co-design workshops, the relevance of the storylines to their everyday lives and which aspects of the storylines and the app they enjoyed or believed needed improvement.

Participant recruitment

Adolescent participants aged 12–17 years were recruited for the study. The recruitment strategy endeavoured to obtain a heterogenous sample of ages, genders and cultural and educational backgrounds using purposive sampling to enhance the diversity of ideas and opinions. Avenues for recruitment in the community involved advertisements for expressions of interest on the [Sydney Children's Hospitals Network] social media accounts and in newsletters in a range of secondary schools across Sydney. All participants provided informed assent and a parent or guardian provided informed consent for workshop participation and publication of de-identified research findings. Participants at the 2-hour co-design workshops received a $AUD50 shopping gift card and those who attended the 1-hour evaluation workshop received a $AUD30 shopping gift card in appreciation of their time.

Data collection

Worksheets, annotated posters, storyboards and other items created during the co-design workshops and preliminary evaluation workshop were compiled after the conclusion of each workshop into the novel design artefacts that constituted the data of the study. Artefacts were scanned to create digital copies and written text was transferred to a digital format for the purposes of data analysis.

Table 1 Demographics of the participants in each workshop

		Co-Design Workshop 1 (*n* = 25)	Co-Design Workshop 2 (*n* = 19)	Evaluation Workshop (*n* = 8)
		n (%)	*n* (%)	*n* (%)
Gender	Female	9 (36)	13 (68)	2 (25)
	Male	16 (64)	6 (32)	6 (75)
Age (in years)	12	5 (20)	1 (5)	2 (25)
	13	6 (24)	1 (5)	4 (50)
	14	4 (16)	0 (0)	0 (0)
	15	2 (8)	4 (21)	1 (12.5)
	16	4 (16)	7 (37)	0 (0)
	17	4 (16)	6 (32)	1 (12.5)

Data analysis

Qualitative content analysis was conducted on the novel design artefacts. Initially an inductive approach was used, where analysis of the data informs the generation of codes [23, 24]. Researchers familiarised themselves with the text and images of each novel design artefact and generated first-round codes. Three researchers (MA, MT, KS) then met at an analysis meeting to discuss the initial codes until consensus was reached on the final codes. Through directed content analysis, these codes were further analysed and were subsequently organised into themes and sub-themes according to Social Cognitive Theory, focussing on adolescents' attitudes, behaviours and environment [12].

Ethics approval was provided by the Sydney Children's Hospitals Network Human Research Ethics Committee (2020/ETH00578).

Results

Forty-four adolescents aged 12–17 years participated in the two co-design workshops: 25 at Workshop 1 and 19 at Workshop 2 (22 female, 22 male) (Table 1). The participants reported their social media preferences and created a range of digital health literacy storylines using storyboards containing images and/or text (Fig. 1). The themes and ideas explored in the workshops (Fig. 2) were used by the researchers and software designers to develop two new storylines for the "mis-Adventures" app (Fig. 3). These two new storylines were beta tested in the follow-up workshop, which was attended by eight of the previous workshop participants (2 female, 6 male) (Table 1) - all were from the first workshop, despite all previous participants having been invited. The themes identified were analysed further to understand adolescents' digital health literacy education needs.

Health topics

A variety of health topics were explored in the storylines created in the co-design workshops. Diet was a common area of interest for many participants. In particular, dietary supplements such as sports drinks, energy drinks, protein powder and herbal remedies were a regular theme. Restrictive diets such as juice cleanses were also mentioned. Physical fitness and gym workouts further served as an undercurrent for many storylines related to diet and nutrition. Other storyline topics included mental health issues such as depression and attention deficit hyperactivity disorder (ADHD), physical illnesses such as acne, headaches, rashes and conjunctivitis, and more serious medical conditions such as seizures and cancer. Dietary supplements and rashes were the topics utilised for the new storylines developed in the app (Fig. 3).

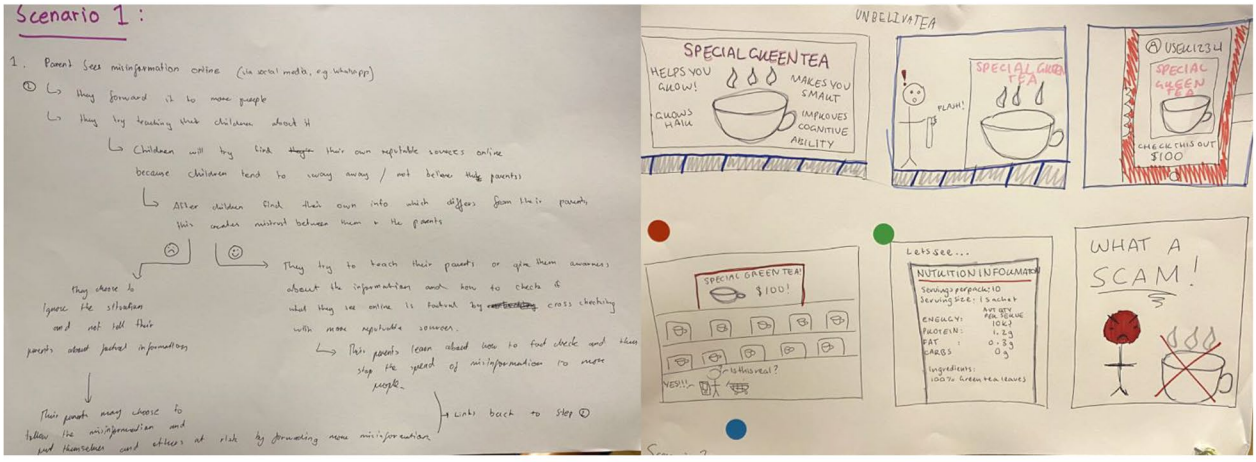

Fig. 1 Examples of the novel design artefacts created in the co-design workshops containing storyboards depicting digital health literacy storylines about navigating online health information

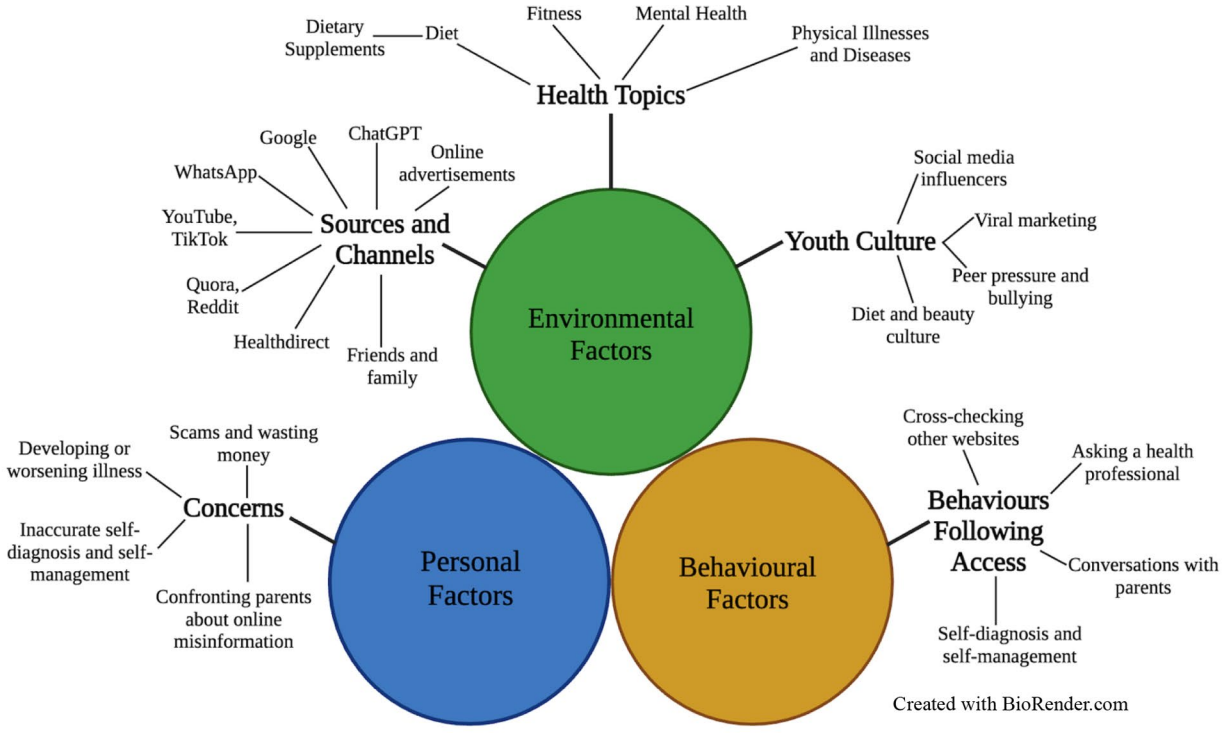

Fig. 2 Thematic schema displaying themes and sub-themes identified in the analysis of the novel design artefacts as related to the three domains of Social Cognitive Theory

Youth culture and online health information

The adolescent participants acknowledged the cultural contexts specific to their age group that inform their interactions with online health information. Multiple participants created storylines about the sports and energy drink brand Prime, which was founded by popular social media influencers. In these storylines, relationships with the influencers were demonstrated to have an impact on how an adolescent perceives health information, with their "idol" status and viral marketing strategies used to promote products that claim to benefit one's health and fitness. The storylines showcased viral marketing strategies that further contributed to the "hype" surrounding certain products amongst the adolescent characters in the stories, who are thus motivated by peer pressure from their friends to purchase the product prior to any online appraisal of health information. Viral marketing was subsequently featured in one of the new "mis-Adventures" storylines (Fig. 3). Participants also mentioned the "toxicity" of diet culture and beauty culture in their storylines, which often informed engagement with health information surrounding nutrition and dietary supplements. They emphasised the role that peer pressure and bullying plays in formulating body standards and influencing how adolescents process health information. Vocabulary commonly used amongst young people such as *"glowing up"*, *"in shape"* and *"bulked"* was present in their storylines in relation to the promotion of restrictive diets and food products with supposed health benefits.

Sources and channels of online health information

Many avenues for seeking and finding health information, both online and offline, were mentioned by participants. When intentionally searching for health information, the storylines showed a proclivity towards asking family and friends, using online search engines like Google™, or looking up government-funded health websites with reliable, high quality health information that they deemed to be *"official"* and *"verified"*, such as Healthdirect [25]. In the posters annotated with participants' social media preferences, there was also a strong inclination towards using video-sharing platforms like YouTube™ and TikTok™ when searching for health information, as well as question-and-answer websites like Quora™ and discussion forum websites like Reddit™. Artificial intelligence (AI) chatbots such as ChatGPT™, whilst frequently used by adolescents, were not as readily used for finding health information. However, many of the participants considered using ChatGPT in the future for this purpose. For this reason, a storyline created at the workshops was adapted into a "mis-Adventures" storyline using ChatGPT to search for health information and

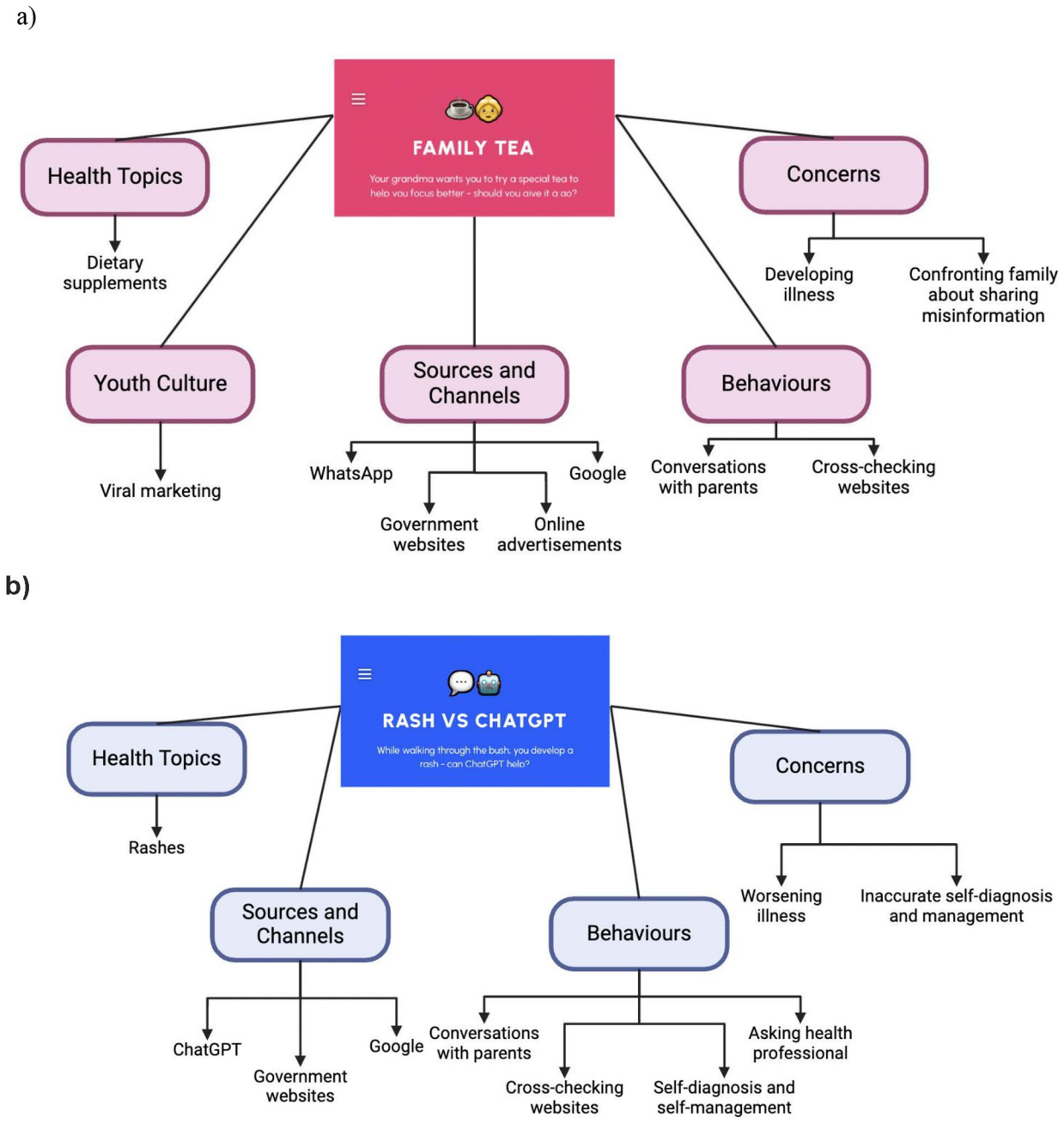

Fig. 3 Themes and sub-themes from the data which were incorporated into the two new storylines for the "mis-Adventures" educational app: **a**) "Family Tea" and **b**) "Rash vs ChatGPT"

government-funded websites like Healthdirect for further fact-checking (Fig. 3).

Adolescents further identified online avenues where they were unintentionally exposed to health information. These primarily took the form of online product advertisements as well as brand promotions and product placements from influencers on social media platforms like Instagram™. Health information was also disseminated via conversations with friends and family members, particularly parents, either via alternative social media such as the messaging service WhatsApp™ or in-person. WhatsApp was used in a new "mis-Adventures" storyline in which a teenage character is inadvertently exposed to a health-related advertisement in a family group chat (Fig. 3).

Behaviours following access to online health information

The storylines showcased a range of possible actions that adolescent protagonists would take after their exposure to health information. If they accessed information in an offline setting, they would most likely use a search engine such as Google to investigate the topic or product further. For both online and offline health information, characters displayed their desire to cross-check using a range of sources they deemed reputable, often indicating their preference for websites with URL domains such as.gov or.org rather than.com to appraise the health information. Many of the storylines further involved searching for and engaging with a health professional, usually a doctor, to verify the health information. Conversations with parents were also apparent in a number of the storylines. Most interactions with parents in the storylines involved seeking advice from them, however some explored appraising viral online health misinformation disseminated by parents and using their newfound knowledge to educate them. Other storylines involved adolescents using the health information gained to self-diagnose a health condition and/or self-medicate. Discussions with parents and health professionals, cross-checking other websites and self-diagnosis and self-management featured in the new "mis-Adventures" storylines (Fig. 3).

Concerns relating to online health information

Many problems and negative outcomes related to accessing and appraising online health information were explored in the storylines devised. A recurring concern was the risk of false advertising and being scammed by online marketing and product placement on social media. Participants explained in their storylines that advertisements for certain products could contain unsubstantiated claims and hyperbole about their benefits for fitness and health. Dietary supplements were often featured in discussions about false health information conveyed through advertising, with particular concerns surrounding their nutritional content. In addition to this, participants emphasised the undesirable outcomes experienced when purchasing products that contain over-exaggerated health benefits, such as wasting money or discovering that the product has a poor taste. This further led to feelings of embarrassment and anger for the characters in their storylines.

Some storylines explored the possibility of developing an illness or exacerbating a current health problem if the characters followed incorrect health information. In worst case scenarios, the poor health advice resulted in hospitalisation and even death. These detrimental outcomes were often related to restrictive diets and supplements, however looking up symptoms and subsequently applying inaccurate health information via self-diagnosis and self-medication also resulted in worsening illness. These negative outcomes were explored in the new storylines developed for the app (Fig. 3). In the storylines concerning online health misinformation shared by adult family members, participants detailed their concern and apprehension about confronting their family and challenging their beliefs, identifying the potential for intergenerational distrust and tension to develop. This was subsequently included in one of the new "mis-Adventures" storylines (Fig. 3).

Evaluation of the "mis-Adventures" app

At the first two co-design workshops, participants reported that the existing "mis-Adventures" app contained engaging, informative and relevant content regarding online health information. They also enjoyed the design and interactive interface of the app, which they reported was easy to navigate. They appreciated the use of clear and understandable language throughout the storylines and found the quizzes and answer explanations embedded into the "problem-solving and decision-making" style of the storylines to be effective in reinforcing key lessons. In terms of improving the app, the participants reported that they would prefer a greater number of storylines on different topics, as well as greater depth, more difficult questions and more journey options for the storylines to explore. They also recommended subtitles and video controls such as pause, play and rewind be added to the video-based components of each storyline for accessibility.

At the beta-testing workshop held after the co-design workshops, participants confirmed that they recognised many of the ideas explored at their co-design workshop within the two new storylines created, specifically regarding the sharing of online misinformation and fact-checking using unreliable websites. The participants reported relating to the storylines in a range of ways, such as finding online advertisements for health-related products through social media and sharing by family members, with multiple participants stating that the stories resonated with them as they contained *"actual problems"* that they may encounter. They commented, however, that the use of ChatGPT for health information was more likely to be within the context of schoolwork and assessments rather than for everyday health concerns, as shown in one of the storylines. Participants expressed an appreciation for showcasing discussions about health information with family members in the storylines rather than just exploring one character's online activity. The participants further stated that they were *"engaged and entertained"* by the new storylines and appreciated the casual nature of the dialogue. Participants reiterated the desire for more storylines exploring different topics. There were specific suggestions for *"more realistic"* storylines that incorporated the school environment in the search for

online health information, such as a storyline involving the completion of a school assignment.

Discussion

The co-design workshops elucidated adolescents' key educational needs to more effectively seek, find, understand and appraise online health information. Useful insight was gained into the health topics and contexts in which adolescents are immersed, both online and offline, and how their lived experiences can be incorporated into educational interventions that aim to improve digital health literacy. The two new digital health literacy storylines developed in the "mis-Adventures" app effectively explored the concerns and behaviours that adolescents expressed when navigating online health information and replicated the everyday environments and interactions of adolescents with high fidelity, thus further creating a relatable and engaging educational resource for improving adolescents' digital health literacy.

Out of the health topics explored during the co-design workshops, the most prevalent was dietary supplements. The digital health literacy storylines that explored this topic highlight the importance of marketing and advertising as a source of online health information for adolescents. These products are often marketed explicitly through online advertisements and sponsored posts from social media accounts [26, 27] but may also be promoted more surreptitiously through the behaviours of influencers and other content creators on social media [28]. Parasocial relationships between adolescents and the social media influencers whom they admire continue to have significant impacts on the health information they receive and the products they purchase as they are more likely to trust social media personalities who appear relatable and inspirational [29]. In line with past studies, adolescents still maintain significant distrust towards advertising and marketing of health-related products [5, 6]. This study demonstrates the potential to integrate digital health literacy with other forms of media literacy, such as marketing literacy and food literacy [27, 30, 31], and how combinations of these different competencies are essential in equipping adolescents with the reasoning required to critically appraise online health information.

Through the workshop activities that inquired about young people's online preferences, it was noted that the use of generative AI tools in efforts to seek and find health information in everyday life is still largely novel for adolescents. Many of them, however, are increasingly using ChatGPT in high school classrooms for the purposes of study and completing assignments [32]. Adolescents report a variety of perspectives on using ChatGPT to access health information, with some expressing apprehension due to a risk of receiving inadequate health information and others being very enthusiastic about its future [32, 33]. The co-design and evaluation workshops allowed for greater understanding of ChatGPT's omnipresence in young people's educational journeys and its potential in providing easily accessible health information. Given the high likelihood that AI-based conversational tools and other technologies will continue to advance and develop higher-order capabilities at searching for, selecting and interpreting relevant health information in the near future [34], it was beneficial to develop a digital health literacy storyline on the "mis-Adventures" app that explored the everyday use of accessible generative AI tools such as ChatGPT to find health information.

Relationships with family, particularly parents, were shown through the workshops to have a significant influence on adolescents' concerns and behaviour when searching for online health information. Many young people continue to fluctuate between levels of trust and apprehension when discussing health topics with their parents. Whilst they are usually keen to discuss everyday physical health-related concerns, many adolescents display a reluctance to challenge parents' biases or discuss stigmatising health issues [7, 35]. Rather than navigate online health information alone, the storylines showed that many adolescents are keen to discuss this information with their parents and value their advice and support. The storylines also display how disagreements about online health information between parents and children can exacerbate distress and contribute towards poor health decisions. As such, the co-design workshops explored the importance of showcasing the integration of adolescents within their families in digital health literacy education as they often navigate online health information and devise solutions together. The educational resource that was co-designed also has potential to encourage parent-child communication on digital health literacy issues in relevant and engaging ways, which could thus strengthen trust and attachment and lead to better health outcomes for adolescents [36–38].

Limitations

There are some limitations to be considered in this study. Despite purposive sampling to ensure a heterogenous group of workshop participants in terms of age, gender and socioeconomic and cultural backgrounds, the recruitment strategy did not specifically target adolescents from rural backgrounds or adolescents who identify as LGBTQIA + or are from other diverse groups (nor were they excluded). As such, the digital health literacy contexts explored in this study may not be transferable to more diverse adolescent populations. Future workshops to develop the educational resource could focus on catering to a wider range of vulnerable and diverse adolescent communities. Whilst the creative and interactive processes of the co-design workshops can effectively elicit

the detailed experiences of adolescents navigating online health information, social desirability bias could be present when evaluating the "mis-Adventures" app and when the participants showcased their creations to researchers and other participants as they may wish to be perceived favourably. The co-designed "mis-Adventures" app was beta tested by participants from the first workshop, who were a little younger than those in the second (all workshop participants had been invited to beta testing). However, similar ideas had been discussed by participants in both initial co-design workshops so we expect participants' responses in the beta-testing workshop would have been similar. Nevertheless, it may be beneficial to conduct beta testing with a larger and broader sample of adolescents across different ages and social and geographical contexts to maximise relevance in further updates and comparison with expert-designed educational resources to further appraise the effectiveness of the co-design approach.

Conclusion

The co-design approach was useful to enhance the relatability and accessibility of a digital health literacy educational resource for adolescents. Co-design was also valuable for understanding the topics and sources where adolescents encounter health misinformation in daily life and their behaviours and concerns when appraising online health information, including communication with family members. Further research into the digital experiences of diverse groups of adolescents and further beta testing of the app would be beneficial to expand on the app and provide other relevant storylines for adolescents' digital health literacy education.

Abbreviations

App software application

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22949-0.

Supplementary Material 1

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Author contributions

Conceptualisation of this study was by KS, PHYC and LB, who also received input from RS and MK. Funding acquisition was undertaken by KS in conjunction with PHYC, RS, MK, MT and LB. Project administration was undertaken by MT and KS, with MA also supporting. KS, with PHYC and MT, played key supervision roles. Methodology was developed by KS and PHYC, with input from RS, MK, MT and LB. MT oversaw resources in this study, with LB, KS, and MA assisting. Investigation was completed by LB, MT, KS, MA and PHYC. Data curation was completed by MA, with assistance from MT and KS. Formal analysis was undertaken by MA, in collaboration with KS, MT and PHYC, who were essential in data validation. The development of 'mis-Adventures' was undertaken by LB. Visualisation of data (Figs. 2 and 3) was completed by MA, with input from KS, PHYC and MT. This manuscript was drafted by MA, in collaboration with KS and MT, and with critical review and editing from KS, PHYC, MT, and MA. All authors have been involved in the manuscript's generation and have approved the final manuscript.

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Data availability

Research data that support the findings of this study are provided within the manuscript.

Declarations

Ethics approval and consent to participate

Ethics approval was provided by the Sydney Children's Hospitals Network Human Research Ethics Committee (2020/ETH00578) in accordance with the Declaration of Helsinki. All participants provided informed assent and a parent or guardian provided informed consent for workshop participation.

Consent for publication

All participants provided informed assent and a parent or guardian provided informed consent for publication of de-identified research findings.

Competing interests

The authors declare no competing interests.

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