Context Sensitive Health Informatics and the Pandemic Boost
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User Experience Co-Design of a Mobile Application to Support Childrearing in Low- and Middle-Income Countries

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Abstract. The widespread adoption of mobile phones and increasing mobile connectivity globally create opportunities to access remote and disadvantaged populations. Mobile health interventions in low- and middle-income countries have substantial reach and potential to promote the socio-emotional and cognitive development of children. This study presents co-design workshop findings relating to the user experience of a mobile application – *Thrive by Five* – which intends to promote healthy early childhood development globally, particularly in low- and middle-income countries. Here, findings from workshops conducted in 11 countries in Asia, Africa, and Oceania are presented. Key feedback on the mobile application user experience indicated several necessary changes, such as simplifying and localising the language, incorporating short videos or animations, adding more bright colours and illustrations, and making numerous improvements and additions to the app features and functionality. The findings contribute to advancing mobile health, context-sensitive technologies, user experience design, and low-resource setting technology co-design.

Keywords. early childhood development, mHealth, LMIC, participatory design, smartphone app

1. Introduction

The ubiquity of mobile phones globally presents an opportunity to distribute childrearing and early childhood development (ECD) information intended to promote the socio-emotional and cognitive development of children during the first five years of life [1]. However, it is crucial to ensure that the use of mobile phones to support health (mHealth) appreciates, among other things, the implementation context [2] and cultural and linguistic diversity [3], especially in low- and middle-income countries (LMICs) [4]. To that end, co-design is one way forward [2].

Co-design seeks to drive creative and meaningful innovation via direct engagement with key stakeholders, such as mHealth end users [5]. This process enables stakeholders to be the expert on their own needs, emphasising genuine participation, prototyping, and

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meaningful action [6]. In digital health research, co-design is being used to develop effective innovations, including eHealth games [7], telehealth [8], and mHealth [9]. Co-designing digital health interventions for LMIC contexts is essential to intervention effectiveness [10], especially mHealth [4]. Further, involving target users in the design process is a key determinant of intervention success in LMICs [11].

The present study centres on the co-design of a mobile application (app) for parents and other child caregivers – *Thrive by Five* (see Figure 1). The app delivers ECD information and complementary childrearing activities, seeking to foster healthy caregiver-child interactions and promote the importance of ECD globally. Principally, the app is adapted to each implementation country to work to ensure cultural appropriateness by including, for instance, local language translations, illustrations featuring familiar clothing and people, and local examples of typical food, greetings, and positive caregiver-child interactions. Broadly, this work aims to (1) co-create the *Thrive by Five* app to ensure usability, acceptability, and cultural appropriateness for parents and other child caregivers in LMICs and (2) facilitate the successful implementation and adoption of the app to promote and optimise socio-emotional and cognitive development of children aged 0-5 [12]. Here, findings from 11 countries in Asia, Africa, and Oceania relating to the app user experience are presented.

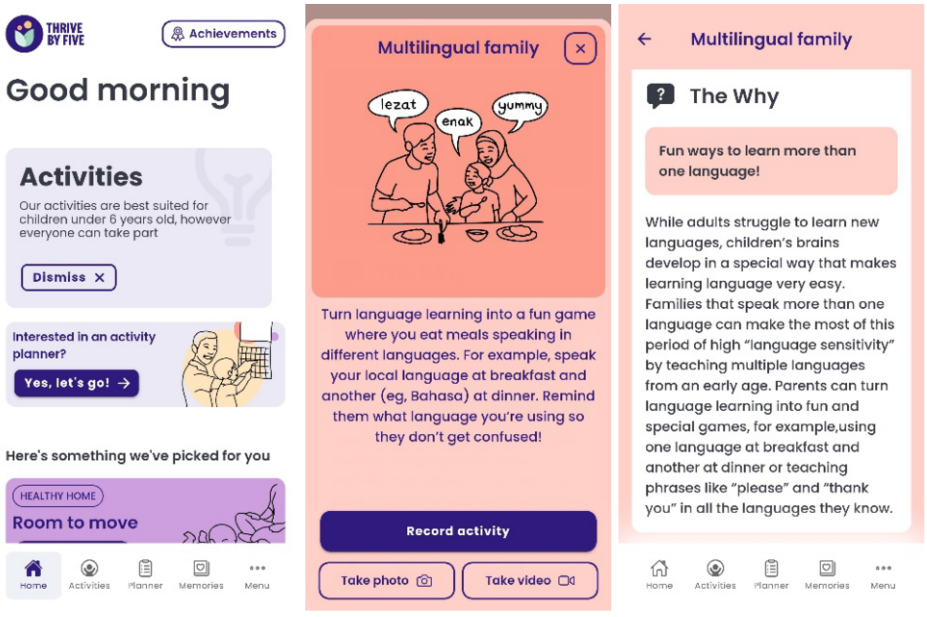

Figure 1. The *Thrive by Five* app version tested in Malaysia, featuring (left to right) the title screen, an exemplary childrearing activity screen 'Multilingual family,' and 'The Why' screen explaining the scientific principles underpinning the associated activity.

2. Methods

Following best practices outlined elsewhere [12,13], co-design workshops were conducted with 211 parents or other child caregivers and 76 in-country subject matter

experts from Afghanistan, Indonesia, Malaysia, Kyrgyzstan, Uzbekistan, Namibia, Kenya, The Democratic Republic of the Congo, Cameroon, Ethiopia, and Papua New Guinea. An average of five workshops were held in each country. To address potential disparities in socioeconomic status, literacy, education, and cultural beliefs and traditions, in-country partners were engaged to help coordinate the workshops and group the participants based on shared culture and demographics. This distribution of participants sought to enable all participants to feel comfortable in sharing their honest opinions, experiences, and beliefs. During the workshops, videoconferencing was utilised to include both in-person and remote attendees.

Workshops were recorded and later transcribed and coded using QSR International's NVivo software package. Thematic analysis was utilised to develop and describe themes based on the workshop feedback [14]. To best inform user experience design, workshop participants were given a walkthrough of the app prototype or a period of hands-on user testing, when possible.

The study has been approved by the University of Sydney Human Research Ethics Committee (Protocol no: 2021/956).

3. Results

One of the themes identified *User experience* captures feedback on participant interactions with the app, with implications for the ongoing app co-design. Feedback is centred on the app's user interface, language, illustrations, features, and functionality. Additional themes identified which are not relevant to the user experience are published elsewhere [15]. Table 1 highlights the *User experience* findings, featuring key participant feedback on the app user experience shared in multiple countries, as well as recommended changes to the app based on that feedback.

Table 1. *User experience* theme findings and recommended changes to the *Thrive by Five* app, by country.

User experience feedback	Recommended changes to the app	Country
App confused for (1) a clinical intervention for identifying developmental delays in children and (2) an app for child users	Add an introductory screen explaining the app's purpose and target users; a disclaimer that it is not a diagnostic tool	Afghanistan, Indonesia, Kyrgyzstan, Papua New Guinea
Requests to further localise the app illustrations	Add illustrations that reflect different living circumstances (e.g., Indonesian rural settings and small living spaces) and groups (e.g., Malaysian three primary population groups)	Ethiopia, Indonesia, Kenya, Malaysia, Papua New Guinea
Add more colourful imagery, including the app illustrations and user interface colour palette	Add colour to the app illustrations and vivid colours to the user interface. Consider enabling customisation of the user interface colour palette	Afghanistan, Kenya, Malaysia, Papua New Guinea, Uzbekistan
Needs video demonstrations to instruct users on the childrearing activities	Add short videos to the app. Alternatively, utilise Graphics Interchange Format (GIF) images to minimise app download size	Cameroon, Ethiopia, Kyrgyzstan, Malaysia, The Democratic Republic of the Congo, Uzbekistan
Add additional local language translations	Add translations for Luo (Kenya), Karakalpak	Kenya, Papua New Guinea, Uzbekistan

	(Uzbekistan), and Motu (Papua New Guinea)	
App content length needs to be reduced; simplify the language	Simplify the content language and reduce the word count	Ethiopia, Kyrgyzstan, Namibia, Papua New Guinea, Uzbekistan
Translations are too literal and too technical	Revise the language to ensure readability	Kyrgyzstan
Requests for features to share the app content online and enable user networking via (1) social network and instant messaging interoperability or (2) in-app user-user chat functions	Add buttons to instantly share content through other apps or buttons to create shareable links. Consider adding a user-user networking feature	Cameroon, Ethiopia, Indonesia, Kenya, Kyrgyzstan, Malaysia, Uzbekistan
Needs to allow users to submit feedback on the app	Add a user feedback feature	Kenya, Kyrgyzstan, Uzbekistan
Include playable children's music	Add a music playback feature and pre-loaded local music	Ethiopia, Malaysia, The Democratic Republic of the Congo
Request to include contact information of local health and support services in the app	Add contact details of local services (e.g., emergency health, paediatricians, and counsellors)	Afghanistan, Ethiopia, Uzbekistan

4. Discussion and Conclusions

Based on feedback from parents, other child caregivers, and subject-matter experts, the *User experience* theme findings indicate various necessary and meaningful changes to improve the user experience of the *Thrive by Five* app. These include avoiding word-for-word translations, simplifying and localising the language, adding more bright colours and illustrations, incorporating videos or animations, and refining and adding various features and functions. Some of the additional feature requests were either out of scope or require further investigation, including suggestions to enable users to share the app content online, communicate with other users through the app, and access information about local health and support services. Yet, all feedback ought to be considered for each applicable implementation country to further localise the app and optimise the user experience, including the out-of-scope feedback which may otherwise be incorporated in novel ways or serve to create an understanding of user needs and expectations.

On limitations, the findings should be considered with caution as most of the feedback came from participants who reported access to smartphones, demonstrated high digital skills and literacy, lived in higher-income households, and had a higher level of educational attainment. As such, the findings do not necessarily reflect the needs, expectations, and experiences of those from all socio-economic backgrounds and those with different levels of digital skills and literacy. Yet, repeated, similar feedback reported across multiple countries improves confidence in the app user experience findings and the recommended changes to the *Thrive by Five* app presented here.

As tools to deliver information, mobile apps have the potential to promote children's socio-emotional and cognitive development. Co-designing these apps creates space for stakeholder engagement, cultural inclusion, and person-centred solutions. In this work, using co-design elected vital user experience feedback to further the ongoing co-creation of a mobile app to support childrearing with and for 11 LMICs. Planned follow-up evaluation of the app, and iterative redesign and testing of the app with stakeholders, will ensure the app incorporates the user experience findings presented here to cater to the needs and expectations of parents and other child caregivers in each implementation

country for the *Thrive by Five* app. This study informs the user experience design of future mobile apps for early childhood development in LMICs, as well as broader technology co-design research engaging end users in resource-limited settings.

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References

[1] Fedele DA, Cushing CC, Fritz A, Amaro CM, Ortega A. Mobile health interventions for improving health outcomes in youth: a meta-analysis. JAMA Pediatrics. 2017;171(5):461-9.
[2] Noorbergen TJ, Adam MT, Roxburgh M, Teubner T. Co-design in mHealth systems development: insights from a systematic literature review. AIS Transactions on Human-Computer Interactions. 2021;13(2):175-205. doi:10.17705/1thci.00147.
[3] Lupton D. Digital health: critical and cross-disciplinary perspectives. London: Routledge; 2017.
[4] Ben-Zeev D, Meller S, Snyder J, Attah DA, Albright L, Le H, et al. A digital toolkit (m-healer) to improve care and reduce human rights abuses against people with mental illness in west Africa: user-centered design, development, and usability study. JMIR Ment Health. 2021;8(7):1-15. doi:10.2196/28526.
[5] Britton GM. Co-design and social innovation: connections, tensions and opportunities. London: Routledge; 2017.
[6] Cantore S. Co-design, volume III: practical ideas for developing across complex systems. New York: Business Expert Press; 2018.
[7] Thabrew H, Stasiak K, Kumar H, Naseem T, Frampton C, Merry S. A cognitive behavioral therapy–, biofeedback-, and game-based ehealth intervention to treat anxiety in children and young people with long-term physical conditions (starship rescue): co-design and open trial. JMIR Serious Games. 2021;9(3):1-14. doi:10.2196/26084.
[8] Beattie M, Morrison C, MacGilleEathain R, Gray N, Anderson J. Near me at home: codesigning the use of video consultations for outpatient appointments in patients' homes. BMJ Open Qual. 2020;9(3):1-8.
[9] Werner-Seidler A, Wong Q, Johnston L, O'Dea B, Torok M, Christensen H. Pilot evaluation of the sleep ninja: a smartphone application for adolescent insomnia symptoms. BMJ Open. 2019;9(5):1-12.
[10] Peiffer-Smadja N, Poda A, Ouedraogo A-S, Guiard-Schmid J-B, Delory T, Le Bel J, et al. Paving the way for the implementation of a decision support system for antibiotic prescribing in primary care in west Africa: preimplementation and co-design workshop with physicians. J Med Internet Res. 2020;22(7):1-16. doi:10.2196/17940.
[11] Jagtap S. Key guidelines for designing integrated solutions to support development of marginalised societies. J Clean Prod. 2019;219:148-65. doi:10.1016/j.jclepro.2019.01.340.
[12] LaMonica HM, Crouse JJ, Song YJC, Alam M, Ekambareshwar M, Loblay V, et al. Co-designing a parenting app to support young children's socioemotional and cognitive development in culturally diverse lower- and middle-income countries: a protocol paper. JMIR Res Protoc. 2022;11(10):1-13.
[13] Poulsen A, Hickie IB, Alam M, Crouse JJ, Ekambareshwar M, Loblay V, et al. Overcoming barriers to mHealth co-design in low- and middle-income countries: a research toolkit. 2023.
[14] Braun V, Clarke V. Thematic analysis. In: Cooper H, Camic PM, Long DL, Panter AT, Rindskopf D, Sher KJ, editors. APA handbook of research methods in psychology, vol 2 research designs: quantitative, qualitative, neuropsychological, and biological. Washington: American Psychological Association; 2012. p.57-71.
[15] Alam M, Hickie IB, Poulsen A, Ekambareshwar M, Loblay V, Crouse JJ, et al. A parenting app to support social, emotional, and cognitive development in early childhood: Iterative co-design learnings from nine low- and middle-income countries. 2023. (under review)