Journal of Healthcare Technology
Volume 1 No 1 February 2025

DEVELOPMENT AND USABILITY TESTING OF MOBILE APPLICATION ON EARLY COGNITIVE, AND SOCIAL-EMOTIONAL DEVELOPMENT IN THE FIRST 6 MONTHS OF LIFE

Dewi Srinatania[1,2], Tukimin bin Sansuwito[3], Idris Adewale Ahmed[4]

[1] Faculty of nursing, Centre of Postgraduate Studies , Lincoln University College Malaysia, malaysia
[2] Department of pediatric nursing, Sekolah Tinggi Ilmu Keperawatan PPNI Jawa Barat, Indonesia
[3] Faculty of Nursing, Lincoln University College Malaysia, Malaysia
[4] Faculty of Applied Science, Lincoln University College Malaysia, Malaysia

Corresponding authors: dewisrinatania@yahoo.com

Received : 03 January 2025 ◦ Revised : 27 January 2025 ◦ Accepted : 06 February 2025

ABSTRACT

Background: The first six months of life play a crucial role in shaping an infant's cognitive and socio-emotional development, laying the foundation for future learning, behavior, and overall well-being. However, many caregivers, especially in low- and middle-income countries struggle to access reliable, research-based guidance on fostering early childhood development (ECD). Mobile health (mHealth) applications offer an innovative solution by providing accessible, evidence-based resources to support caregivers in nurturing their child's growth.

Aims: This study developed and evaluated the usability of *Stimulus Apps*, a mobile application designed to support early cognitive and socio-emotional development in infants aged 0–6 months. The app offers guidance on responsive caregiving, developmental milestones, and interactive activities.

Methods: A mixed-methods approach was used, consisting of two key phases: (1) app development and (2) usability evaluation. The app was designed using established frameworks and expert consultations, integrating features such as educational content, milestone tracking, interactive activities, and caregiver forums. Usability testing involved 30 caregivers who participated in a cross-sectional study. The System Usability Scale (SUS) measured usability, while semi-structured interviews provided deeper insights into user experience and functionality. Quantitative data were analyzed using descriptive statistics, and qualitative feedback was examined through thematic analysis.

Results: A total of 30 caregivers (73.3% mothers, 20% fathers, 6.7% guardians) participated, with an average age of 29.4 years (SD = 4.2). The *Stimulus Apps* received a mean SUS score of 78.6 (SD = 8.5), indicating a high level of usability. Qualitative findings highlighted three main themes: (1) ease of use and navigation, (2) perceived usefulness and engagement, and (3) areas for improvement. Caregivers appreciated the app's intuitive design, milestone tracking, and video-based educational content. However, they suggested enhancing app performance, adding more interactive learning tools, and providing personalized activity recommendations.

Conclusion: The *Stimulus Apps* mobile application demonstrated strong usability and was well-received by caregivers, offering valuable support for early cognitive and socio-emotional development. Future improvements should focus on optimizing app performance, incorporating interactive features, and tailoring content to meet user needs. This study highlights the potential of mHealth interventions in promoting positive caregiving practices and improving early childhood development outcomes.

Keywords: early childhood development, mobile health application, cognitive development, socio-emotional development, usability testing, parenting support

INTRODUCTION

The first six months of life are a critical period for a baby's growth, laying the foundation for lifelong learning, behavior, and overall well-being (Shonkoff et al., 2000). During this time, the brain develops rapidly, shaped by a child's environment and interactions with caregivers (Fox et al., 2010). Studies show that when caregivers engage in nurturing, responsive practices, children benefit significantly in their cognitive and socio-emotional development

(Britto et al., 2017). However, many caregivers—especially those in resource-limited settings—lack access to reliable, evidence-based support to guide them during this crucial stage (Black et al., 2017).

Early development is about more than just physical milestones—it includes key abilities like attention, memory, emotional regulation, and social interaction (Bangor et al., 2008). These skills grow best in a supportive environment where caregivers respond to their baby's cues and provide stimulating interactions (Tamis-LeMonda et al., 2014). While the importance of early childhood development (ECD) is widely recognized, many caregivers struggle to find practical, research-backed tools to help them nurture their child's growth (Rafla et al., 2024). This gap has led to the rise of mobile health (mHealth) applications, offering scalable and accessible solutions for early childhood development support (Smith et al., 2020).

Recent research highlights the potential of mHealth apps in empowering caregivers with knowledge and engagement strategies. For instance, a randomized controlled trial by (Rafla et al., 2024) showed that a mobile-based intervention improved caregiver involvement in developmental activities and led to better child outcomes in low-income communities. Similarly, (Jeong et al., 2021) found that a parenting app offering developmental milestone tracking and guidance boosted caregiver confidence and awareness. However, most existing apps provide general parenting advice rather than focusing on specific aspects of early development—particularly cognitive and socio-emotional growth during the first six months of life (Smith et al., 2020). Additionally, there is limited research on how well these apps work for diverse caregiver populations, especially in low- and middle-income countries (LMICs) where such tools are most needed (Doyle et al., 2009)

Despite the promising potential of mHealth interventions, there remains a significant gap in mobile applications specifically designed to support cognitive and socio-emotional development in the earliest months of life. Many existing apps either fail to integrate research-backed strategies or have not undergone rigorous usability testing, limiting their effectiveness and scalability (Doyle et al., 2009; Rafla et al., 2024). Furthermore, there is a lack of research on how culturally adaptable and user-friendly these applications are, particularly in LMICs, where access to early childhood development resources is often limited (Black et al., 2017). Addressing these challenges is crucial in designing user-centered, evidence-based tools that effectively support caregivers in fostering their baby's development.

This study aims to develop and evaluate a mobile application specifically designed to promote early cognitive and socio-emotional development during the first six months of life. The app will provide research-based guidance on responsive caregiving, developmental milestones, and interactive activities tailored to this formative period. To ensure its effectiveness, usability testing will assess user-friendliness, cultural relevance, and overall impact in meeting the needs of diverse caregivers.

METHODS

Study Design

This study employed a mixed-methods approach, combining both quantitative and qualitative methods to develop and assess the usability of a mobile application aimed at supporting early cognitive and social-emotional development

in infants during their first six months of life. The study was conducted in two primary phases: (1) mobile application development and (2) usability testing with the target user group. During the development phase, an extensive literature review was conducted, expert consultations were sought, and an iterative prototyping process was implemented to refine the app. The usability testing phase utilized a cross-sectional design to evaluate the app's functionality, user experience, and acceptability among caregivers of infants aged 0–6 months.

Sample

For the usability testing phase, a purposive sampling strategy was employed to recruit participants who best represented the target users—primary caregivers, including parents and guardians of infants aged 0–6 months. Participants were recruited from urban and semi-urban communities through community health centers, pediatric clinics, and social media platforms.

Eligibility criteria included fluency in the app's primary language (English), ownership of a smartphone, and no prior experience with similar mobile applications. A total of 30 caregivers were selected, ensuring data saturation for qualitative insights and adequate statistical power for quantitative analysis (Hennink et al., 2017).

Instrument

The mobile application, Stimulu Apps, was developed based on an evidence-based framework aligned with recommendations from the World Health Organization (WHO) and the American Academy of Pediatrics (AAP) regarding early childhood development. Stimulus Apps was develop using a server-client architecture built on top of the HyperText Transfer Protocol (HTTP) and the Web API (Application Programming Interface). MySQL will utilize as the database with Apache Tomcat and the Spring Framework as the server framework. There are nine features in Stimulus Apps (shown in Figure 1), namely: 1) registration; 2) home page with main menu; 3) account setting; 4) educational material; 5) cognitive, social-emotional development tracker; 6) development diary; 6) online discussion; 7) quiz; and 8) video education.

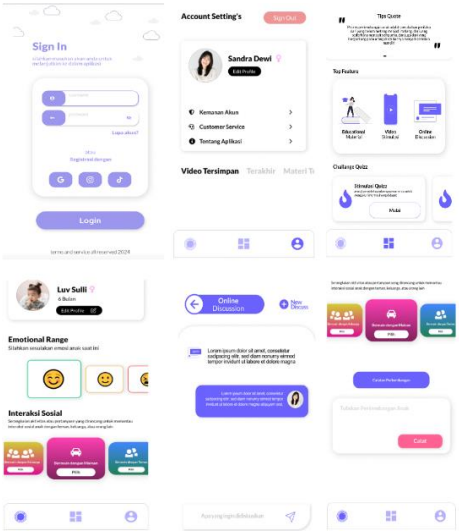

Figure 1. User interface of stimulus mobile application

Usability was evaluated using the System Usability Scale (SUS), a widely recognized 10-item questionnaire measuring user perceptions of usability and satisfaction (Brooke, 1996). Additionally, semi-structured interviews were conducted to gain deeper insights into user experience, app functionality, and cultural relevance from the caregivers' perspectives.

Procedure

The study was conducted over a six-month period, beginning with the app development phase. A multidisciplinary team of pediatricians, developmental psychologists, and software engineers collaborated to design and refine the EarlyCare application. The prototype underwent three rounds of internal testing

before being finalized for usability evaluation. During the usability testing phase, participants were granted access to the EarlyCare app and used it for a period of two weeks. Following this, they completed the SUS questionnaire and participated in semi-structured interviews, which were conducted either in person or via video conferencing. All interviews were audio-recorded, transcribed verbatim, and analyzed to extract key themes.

Prior to the study's commencement, ethical approval was obtained from the Institutional Review Board (IRB) of STIKep PPNI Jawa Barat, and all participants provided written informed consent.

Data Analysis

Quantitative data from the SUS questionnaire were analyzed using descriptive statistics, including mean scores, standard deviations, and frequency distributions. Based on established benchmarks, an SUS score above 68 is indicative of good usability (Brooke, 1996)

For qualitative data, thematic analysis was conducted following (Braun & Clarke, 2006) six-step framework. Interview transcripts were reviewed and coded inductively to identify key themes related to user experience, perceived usefulness, and areas requiring improvement. To enhance the reliability of findings, data triangulation was employed, integrating both quantitative and qualitative results.

RESULTS

Participant Characteristics

A total of 30 caregivers participated in the usability testing phase. The majority of participants were mothers (n = 22, 73.3%), followed by fathers (n = 6, 20%) and other guardians (n = 2, 6.7%). The average participant age was 29.4 years (SD = 4.2). Most caregivers (n = 25, 83.3%) had completed at least secondary education or higher. All participants owned a smartphone, but none had prior experience using a similar mobile application. Participants were recruited from both urban (n = 18, 60%) and semi-urban (n = 12, 40%) communities.

Table 1. Demographic Characteristics of Participants

Characteristic	Frequency (n)	Percentage (%)
Mothers	22	73.3
Fathers	6	20.0
Other guardians	2	6.7
Mean age (years)	29.4	SD = 4.2
Secondary education or higher	25	83.3
Smartphone ownership	30	100.0
Prior app experience	0	0.0
Urban residence	18	60.0
Semi-urban residence	12	40.0

System Usability Scale (SUS) Scores

The usability of the application was quantitatively assessed using the System Usability Scale (SUS). The mean SUS score for the Stimulu Apps was 78.6 (SD = 8.5), indicating a high level of usability based on established benchmarks (Bangor et al., 2008). Table 2 provides a detailed distribution of SUS scores among participants.

Table 2. System Usability Scale (SUS) Score Distribution

SUS Score Range	Number of Participants	Percentage (%)
Above 80	18	60.0

68 - 80	8	26.7
Below 68	4	13.3

Qualitative Findings

Thematic analysis of semi-structured interviews identified three key themes related to the user experience of Stimulu Apps: (1) Ease of Use and Navigation, (2) Perceived Usefulness and Engagement, and (3) Areas for Improvement.

Ease of Use and Navigation

Participants generally found Stimulua Apps easy to navigate. A majority (n = 26, 86.7%) described the app as intuitive and user-friendly. Many caregivers appreciated its simple interface and clear instructions, which facilitated quick adoption. One participant stated:

"I found the app easy to use even on the first try. The menus were clearly labeled, and I didn't have any trouble navigating through the features."

Perceived Usefulness and Engagement

Caregivers highlighted the practicality and engaging nature of the app's features, particularly the educational materials, development tracker, and video education. 23 caregivers (76.7%) found the cognitive and social-emotional development tracker highly beneficial for monitoring their child's progress. 21 caregivers (70%) valued the video education feature, noting that the visual format enhanced their understanding. 19 caregivers (63.3%) found the online discussion forum useful for sharing experiences with other caregivers. One participant shared:

"The development tracker gave me a clearer understanding of my baby's growth, and the video section was very informative. I liked how I could access all the information in one place."

Areas for Improvement

While feedback was largely positive, participants identified several areas that could be enhanced**:** Performance and loading speed: Some users (n = 6, 20%) reported occasional delays when accessing video content. More interactive features: A few caregivers (n = 4, 13.3%) suggested incorporating interactive quizzes and gamified learning elements to boost engagement. Personalized recommendations: Some participants (n = 5, 16.7%) expressed interest in customized activity suggestions based on their child's developmental progress. One caregiver suggested:

"It would be great if the app could recommend specific activities based on my baby's progress. Right now, I have to explore everything myself."

Integration of Quantitative and Qualitative Findings

The combination of quantitative (SUS scores) and qualitative (thematic analysis) findings reinforced the app's overall usability while identifying potential areas for enhancement. High SUS scores aligned with caregivers' positive feedback on ease of use and usefulness. Meanwhile, qualitative insights provided a deeper understanding of specific areas that could be improved to enhance functionality and user engagement.

DISCUSSION

The Stimulus App received positive usability ratings, with an average System Usability Scale (SUS) score of 78.6—well above the standard benchmark of 68 (Hyzy et al., 2022). This suggests that users found the app intuitive and easy to use. Similar trends have been observed in other healthcare applications; for instance, the SmartMed app, designed for anticoagulation management, achieved a mean SUS score of

81.49, reflecting high user satisfaction (Wang et al., 2022). Likewise, the DIGICOG-MS app, created for individuals with multiple sclerosis, reported an even higher SUS score of 84.5, reinforcing the importance of user-centered design in healthcare technology (Podda et al., 2024). Caregivers using the Stimulus App highlighted its ease of navigation, practical benefits, and engaging features. These findings align with previous research showing that well-designed health applications can improve user engagement and support health management (Høgsdal et al., 2023). However, there is room for improvement. Users suggested enhancing app performance, incorporating interactive learning tools, and adding personalized content recommendations. These refinements are essential, as studies indicate that optimizing app functionality and tailoring content can significantly boost engagement and user satisfaction (Albrink et al., 2024).

The positive usability outcomes suggest that the Stimulus App could be a valuable resource for caregivers of infants aged 0–6 months. By offering an accessible and supportive platform, the app has the potential to enhance caregiving practices and contribute to better infant developmental outcomes. Identifying key areas for improvement also provides a clear path for future updates, ensuring that the app continues to meet caregivers' needs effectively.

Limitations

While the findings are promising, this study has some limitations. The sample size was relatively small, which may affect the generalizability of the results. Additionally, the study relied on self-reported data, which can be subject to biases. Future research should include larger, more diverse samples and incorporate objective assessments to strengthen the validity of the findings.

CONCLUSION

The Stimulus App demonstrates strong usability and offers meaningful benefits for caregivers of infants aged 0–6 months. While some areas for improvement remain, the app shows great potential as a supportive tool for early childhood caregiving. Future development efforts should focus on performance optimization, interactive learning features, and personalized content to further enhance the user experience and maximize the app's impact.

Conflict of interest

All authors declare no conflict of interest

Acknowledgement

We thanks to all participant to join in this study. This study was funded by STIKep PPNI Jawa Barat.

REFERENCES

Albrink, K., Schröder, D., Joos, C., Müller, F., & Noack, E. M. (2024). Usability of an App for Medical History Taking in General Practice From the Patients' Perspective: Cross-Sectional Study. *JMIR Human Factors*, *11*(1), e47755. https://doi.org/10.2196/47755

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the system usability scale. *Intl. Journal of Human–Computer Interaction*, *24*(6), 574–594. https://doi.org/10.1080/10447310802205776

Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., McCoy, D. C., Fink, G., Shawar, Y. R., & Shiffman, J. (2017). Early childhood development coming of age: science through the life course. *The Lancet*, *389*(10064), 77–90.

https://doi.org/10.1016/S0140-6736(16)31389-7

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp0630a

Britto, P. R., Lye, S. J., Proulx, K., Yousafzai, A. K., Matthews, S. G., Vaivada, T., Perez-Escamilla, R., Rao, N., Ip, P., & Fernald, L. C. H. (2017). Nurturing care: promoting early childhood development. *The Lancet*, *389*(10064), 91–102. https://doi.org/10.1016/S0140-6736(16)31390-3

Brooke, J. (1996). SUS-A quick and dirty usability scale. *Usability Evaluation in Industry*, *189*(194), 4–7.

Doyle, O., Harmon, C. P., Heckman, J. J., & Tremblay, R. E. (2009). Investing in early human development: timing and economic efficiency. *Economics & Human Biology*, *7*(1), 1–6. https://doi.org/10.1016/j.ehb.2019.01.002

Fox, S. E., Levitt, P., & Nelson III, C. A. (2010). How the timing and quality of early experiences influence the development of brain architecture. *Child Development*, *81*(1), 28–40. https://doi.org/10.1111/j.1467-8624.2009.01380.x

Høgsdal, H., Kaiser, S., & Kyrrestad, H. (2023). Adolescents' assessment of two mental health–promoting mobile apps: results of two user surveys. *JMIR Formative Research*, *7*(1), e40773. https://doi.org/10.2196/40773

Hyzy, M., Bond, R., Mulvenna, M., Bai, L., Dix, A., Leigh, S., & Hunt, S. (2022). System usability scale benchmarking for digital health apps: meta-analysis. *JMIR MHealth and UHealth*, *10*(8), e37290. https://doi.org/10.2196/37290

Jeong, J., Franchett, E. E., Ramos de Oliveira, C. V, Rehmani, K., & Yousafzai, A. K. (2021). Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. *PLoS Medicine*, *18*(5), e1003602. https://doi.org/10.1371/journal.pmed.1003602

Podda, J., Tacchino, A., Ponzio, M., Di Antonio, F., Susini, A., Pedullà, L., Battaglia, M. A., & Brichetto, G. (2024). Mobile Health App (DIGICOG-MS) for Self-Assessment of Cognitive Impairment in People With Multiple Sclerosis: Instrument Validation and Usability Study. *JMIR Formative Research*, *8*, e56074. https://doi.org/10.2196/56074

Rafla, J., Schwartz, K., Yoshikawa, H., Hilgendorf, D., Ramachandran, A., Khanji, M., Seriah, R. A., Al Aabed, M., Fityan, R., & Sloane, P. (2024). Cluster randomized controlled trial of a phone-based caregiver support and parenting program for Syrian and Jordanian families with young children. *Early Childhood Research Quarterly*, *69*, 141–153.

Shonkoff, J. P., Phillips, D. A., & Council, N. R. (2000). Promoting healthy development through intervention. In *From neurons to neighborhoods: The science of early childhood development*. National Academies Press (US).

Tamis-LeMonda, C. S., Kuchirko, Y., & Song, L. (2014). Why is infant language learning facilitated by parental responsiveness? *Current Directions in Psychological Science*, *23*(2), 121–126. https://doi.org/10.1177/0963721414522813

Wang, S.-W., Chiou, C.-C., Su, C.-H., Wu, C.-C., Tsai, S.-C., Lin, T.-K., & Hsu, C.-N. (2022). Measuring mobile phone application usability for anticoagulation from the perspective of patients, caregivers, and healthcare professionals. *International Journal of Environmental Research and Public Health*, *19*(16), 10136.