# A mobile application for managing children's behavioral problems: Protocol for the development and pilot implementation using the ADDIE model

Hyunyoung Lee, Anna Lee

Submitted to: JMIR Research Protocols
on: August 11, 2025

# *Table of Contents*

# A mobile application for managing children's behavioral problems: Protocol for the development and pilot implementation using the ADDIE model

Hyunyoung Lee[1] BSN; Anna Lee[1, 2, 3] PhD

[1] College of Nursing and Brain Korea 21 FOUR Project, Yonsei University Seoul KR
[2] Mo-Im Kim Nursing Research Institute, Yonsei University Seoul KR
[3] Institue for Innovation in Digital Healthcare, Yonsei University Seoul KR

**Corresponding Author:**
Anna Lee PhD

College of Nursing and Brain Korea 21 FOUR Project, Yonsei University
50-1, Yonsei-Ro, Seodaemun-gu
Seoul
KR



## *Abstract*

**Background:** Children often exhibit behavioral problems due to rapid developmental changes that can negatively affect their development as well as the quality of life of their families and the broader society. Positive parenting and parental self-efficacy(PSE) have been shown to mitigate behavioral problems. Mobile health solutions are emerging as an effective way to deliver parenting programs.

**Objective:** We describe a protocol for developing and piloting a mobile application designed to enhance positive parenting and PSE in addressing children's behavioral problems.

**Methods:** The application development follows the Analysis, Design, Development, Implementation, and Evaluation model. Literature reviews, focus group interviews, and market research are conducted to identify evidence-based theoretical framework needs and goals. We design the application's main features based on the theoretical framework. A beta version will be developed and evaluated through expert validation and small-scale user testing to gather feedback. Thereafter, a pilot test will be conducted with 20 caregivers. The application's effects and usability will be assessed based on app usage data, questionnaires (including the System Usability Scale, Parental Sense of Competence Scale, and Eyeberg Child Behavior Inventory), and user interviews.

**Results:** In the analysis phase, a total of 54 studies and 18 parenting-related mobile applications were reviewed, revealing that PSE is a core target for intervention and that few existing applications offer comprehensive, theory-based interventions. To address this gap, the proposed app was designed to integrate all four sources of Bandura's self-efficacy theory—enactive mastery, vicarious experience, verbal persuasion, and physiological arousal—providing a uniquely targeted digital intervention. In the design phase, core functionalities were developed based on behavior change techniques aligned with the theoretical framework, including behavior tracking, peer support through user communities, positive feedback, and personalized education. The development phase is currently underway. A pilot study, scheduled for September 2025, will play a crucial role in evaluating the app's feasibility, usability, and preliminary effectiveness, ensuring a robust testing process.

**Conclusions:** Through this application, we anticipate a significant enhancement in parents' PSE, equipping them with better tools to manage their children's behavioral problems effectively.

(JMIR Preprints 11/08/2025:82196)
DOI: https://doi.org/10.2196/preprints.82196

## Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http
No. Please do not make my accepted manuscript PDF available to anyone. I understand that if I later pay to participate in <a href="https:/

# Original Manuscript

Study Protocol

Hyunyoung Lee[1], BSN, RN; Anna Lee[1,2,3*], PhD, RN

[1]College of Nursing and Brain Korea 21 FOUR Project, Yonsei University, Seoul, South Korea
[2]Mo-Im Kim Nursing Research Institute, Yonsei University, Seoul, South Korea
[3]Institue for Innovation in Digital Healthcare, Yonsei University, Seoul, South Korea

[*]Corresponding author: Anna Lee, PhD, RN[2], ORCID No: 0000-0001-9277-8204,

Mo-Im Kim Nursing Research Institute, College of Nursing, Yonsei University, 50-1, Yonsei-Ro,

Seodaemun-gu, Seoul, 03722, Republic of Korea.

Email: annalee716716@gmail.com/annalee@yuhs.ac; Phone: 82-2-2228-3284

# A mobile application for managing children's behavioral problems: Protocol for the development and pilot implementation using the ADDIE model

## Abstract

**Background:** Children often exhibit behavioral problems due to rapid developmental changes that can negatively affect their development as well as the quality of life of their families and the broader society. Positive parenting and parental self-efficacy(PSE) have been shown to mitigate behavioral problems. Mobile health solutions are emerging as an effective way to deliver parenting programs.

**Objectives:** We describe a protocol for developing and piloting a mobile application designed to enhance positive parenting and PSE in addressing children's behavioral problems.

**Methods:** The application development follows the Analysis, Design, Development, Implementation, and Evaluation model. Literature reviews, focus group interviews, and market research are conducted to identify evidence-based theoretical framework needs and goals. We design the application's main features based on the theoretical framework. A beta version will be developed and evaluated through expert validation and small-scale user testing to gather feedback. Thereafter, a pilot test will be conducted with 20 caregivers. The application's effects and usability will be assessed based on app usage data, questionnaires (including the System Usability Scale, Parental Sense of Competence Scale, and Eyeberg Child Behavior Inventory), and user interviews.

**Results:** In the analysis phase, a total of 54 studies and 18 parenting-related mobile applications were reviewed, revealing that PSE is a core target for intervention and that few existing applications offer comprehensive, theory-based interventions. To address this gap, the proposed app was designed to integrate all four sources of Bandura's self-efficacy theory—enactive mastery, vicarious experience, verbal persuasion, and physiological arousal—providing a uniquely targeted digital intervention. In the design phase, core functionalities were developed based on behavior change techniques aligned with the theoretical framework, including behavior tracking, peer support through user communities, positive feedback, and personalized education. The development phase is currently underway. A pilot study, scheduled

for September 2025, will play a crucial role in evaluating the app's feasibility, usability, and preliminary effectiveness, ensuring a robust testing process.
**Conclusion:** Through this application, we anticipate a significant enhancement in parents' PSE, equipping them with better tools to manage their children's behavioral problems effectively.

**Keywords**
ADDIE model, children's behavioral problems, mobile applications, parental self-efficacy, positive parenting

## 1. Introduction

Children undergo rapid developmental transitions that require them to adapt to new environments and adjust their behavior accordingly. These developmental changes often lead to behavioral problems during childhood[1]. Behavioral problems are defined as symptomatic expressions of maladjustment that are considered concerning or undesirable according to the norms of conventional society[2]. The worldwide pooled prevalence of disruptive behavior disorders has been estimated at 5.7% across 27 countries, representing every global region[3]. A study in Korea revealed that 7–13% of children aged 3–5 years showed behavioral problems, and 3–4% required professional intervention to manage their issues[4]. Moreover, behavioral problems are particularly prevalent in children with developmental disabilities, affecting 48–60% of children with intellectual disabilities and 90% of children with autism spectrum disorder (ASD)[5].

Behavioral problems may be a natural part of developmental changes; however, without proper management, they can have a serious negative impact on children, their families, and society. Children with behavioral problems often struggle to express themselves and understand others' emotions, which can adversely affect their social adjustment and academic competence[1, 6]. Children's behavioral problems can also impose physical, psychological, and financial stress on family members, leading to a decline in their quality of life[7]. Furthermore, children's behavioral problems often continue as antisocial behaviors during adolescence, resulting in a substantial social burden[8]. Research conducted in 2004 has estimated that the minimum cost of adolescent problem behaviors amounted to approximately 2.25 billion dollars (3 trillion KRW)[9]. Therefore, it is essential to identify factors that influence children's behavioral problems and develop targeted interventions to manage them effectively.

Parenting is a key factor influencing children's development, and certain parenting behaviors are regarded as more favorable for addressing children's behavioral issues. Parenting styles are generally categorized as authoritative, authoritarian, permissive, or neglectful[10, 11]. Authoritarian, permissive, and neglectful parenting behaviors are related to higher levels of externalizing behavior. By contrast, an authoritative parenting style, characterized by warmth and behavioral control, is negatively associated with children's externalizing behaviors[12].

Positive parenting represents parenting skills that reflect authoritative parenting, defined as the ongoing relationship between a parent and a child, encompassing care, teaching, guidance, communication, and provision of a child's needs[13]. Numerous studies have demonstrated the efficacy of positive parenting in reducing children's behavioral problems, alleviating parental stress, and promoting children's successful development[14, 15].

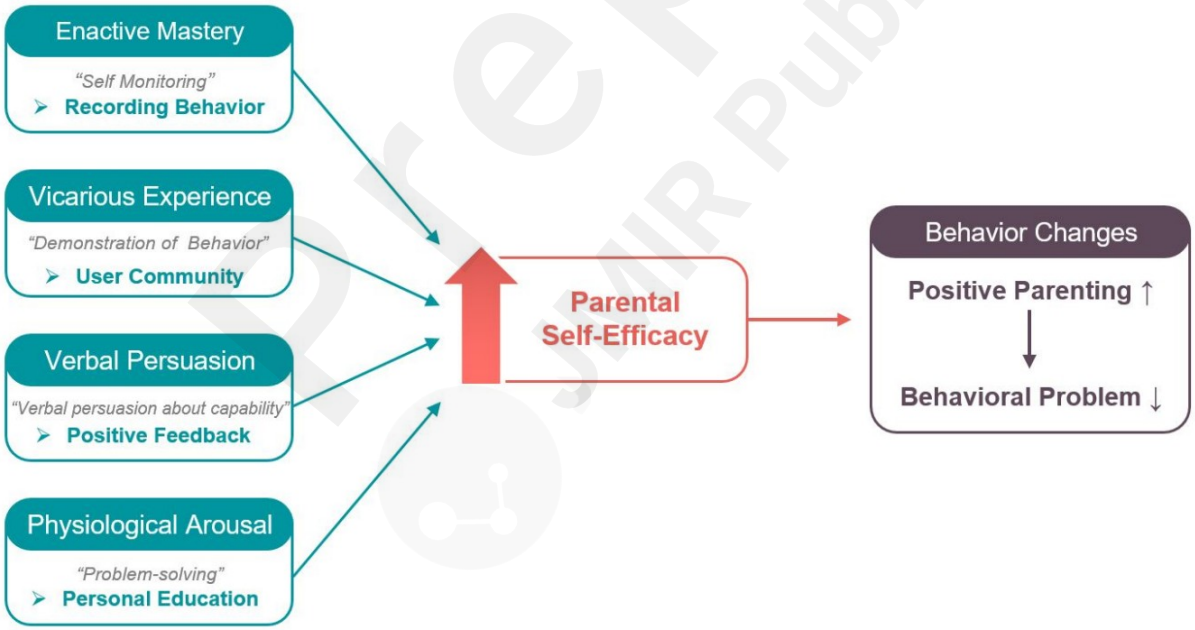
Positive parenting is closely associated with parental self-efficacy (PSE)[16]. Self-efficacy reflects an individual's perception of their ability to influence outcomes. Bandura theory suggests four core elements of self-efficacy: enactive mastery (success through direct experience that builds confidence in one's ability), vicarious experience (increasing confidence by observing others succeed), verbal persuasion (encouragement from others to strengthen belief in oneself), and physiological arousal (physical and emotional reactions influencing confidence)[17]. PSE is a caregiver's belief in their ability to parent effectively, reflecting their confidence in promoting their children's positive development and managing challenges[18]. PSE, directly and indirectly, influences children's adjustment through parenting practices; lower PSE levels are associated with a higher incidence of externalizing behavioral problems in

children[19].

Various parent-involvement interventions that are evidence-based, effective, and cost-effective in addressing children's behavioral problems (e.g., Incredible Years, PCIT, and Triple P) have been developed to enhance PSE[20]. However, few families receive evidence-based interventions due to their low availability, accessibility, and fidelity. To address these challenges, efforts have been made to transition to digital methods for delivering interventions aimed at managing behavioral problems[21].

In particular, mobile health (mHealth) has emerged as a promising method for delivering parenting programs to parents of children with behavioral problems[22]. The penetration rate of smartphone usage in South Korea is approximately 94.8%, which is significantly higher than the global average of 69% and is attributed mainly to the country's well-established IT infrastructure[23, 24]. Moreover, the integration of artificial intelligence (AI) into the healthcare field has enabled the exploration of personalized care approaches through big data analysis[25]. Such approaches can potentially improve outcomes and effectively deliver interventions[26]. Given these factors, delivering parenting interventions through mobile apps integrated with AI appears to be a highly feasible and effective solution.

Therefore, we aim to develop a mobile app grounded in Bandura's self-efficacy theory to enhance PSE, foster positive parenting skills, and ultimately reduce behavioral problems in children (Figure 1). The objective of this study is to describe the protocol for developing and pilot implementing the mobile app.



## 2. Methods

The development of the mobile app was guided by the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model[27](Figure 2). This instructional system design model is widely applied in educational programs and frequently employed in the development of academic and training programs in the healthcare field[28-30].

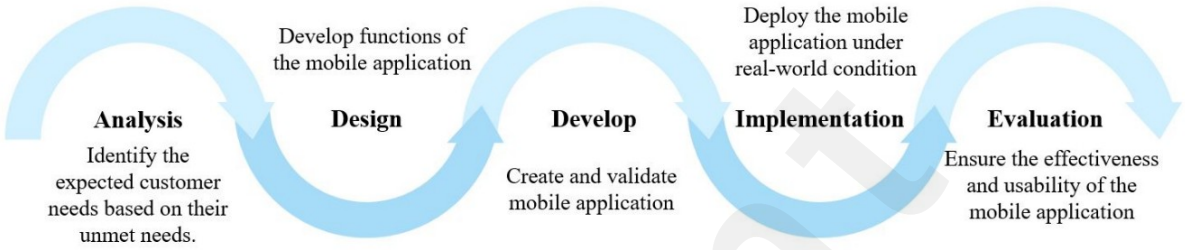



Table1 provides a comprehensive overview of the implementation of the ADDIE model in the current mobile app development, outlining the key steps, methods, and outputs. Additionally, throughout the app development process, we will ensure adherence to the mobile health evidence reporting and assessment (mERA) checklist, a standardized framework designed to enhance transparency, comprehensiveness, and consistency in reporting mHealth research[31].

**Table 1. Overview of the ADDIE model**

| Phase | Key steps | Methods | Outcomes |
|---|---|---|---|
| Analysis | Reviewing existing theories and intervention studies | Literature review | Evidence-based theoretical framework |
| | Analyzing market needs and existing applications | Application market research | Benchmarking elements<br>Differentiations strategies<br>Implementation objectives |
| Design | Developing primary functions | Mapping behavior change techniques | Primary functions<br>Application content flow |
| | Designing user-friendly UX/UI | Wireframing | |
| Development | Developing a beta version | Outsourcing | Feedback from experts and user groups<br>Beta version of the application |
| | Conducting expert validity verification | Expert validity test | |
| | Testing a beta version with a small user group | User testing | |
| Implementation | Conducting a pilot study | User testing | Application data |

| | | | |
|---|---|---|---|
| Evaluation | Evaluating the effectiveness of the application | Surveys<br>Data analysis | Verification of the application's effectiveness<br>User's feedback<br>Final version of the application |
| | Conducting a user satisfaction survey | Surveys<br>User interview | |

## 2.1. Analysis phase

### *2.1.1. Reviewing existing theories and intervention studies*

The first key step involved a thorough literature review to investigate current interventions and theoretical frameworks related to the management of children's behavioral problems. A comprehensive search was conducted on December 23, 2024, using two major academic databases—PubMed and CINAHL. The search strategy was structured around two thematic categories: (1) parenting interventions and (2) behavioral issues in children. Keywords used in the search included "Parenting program," "Behavioral therapy," "Parent intervention," and "Parenting guideline," encompassing a wide range of studies, interventions, and official guidelines relevant to parenting and child behavioral management.

### *2.1.2. Analyzing market needs and existing applications*

In the market analysis, we reviewed related applications on platforms such as the Google Play Store and Apple App Store over a two-week period (January 15-29, 2025). Search keywords included both English and Korean terms, such as "parenting" and "child behavior." Applications were screened and selected based on predefined inclusion and exclusion criteria, which are presented in Table 2. Each application was then reviewed in terms of its core functions, usability features, and user feedback to inform benchmarking and differentiation strategies.

| Category | Criteria |
|---|---|
| **Inclusion Criteria** | (1) Applications developed for use by parents or caregivers<br>(2) Applications including features related to parenting practices, such as behavioral guidance, parenting tips, or intervention support |
| **Exclusion Criteria** | (1) Applications focused solely on child growth and developmental milestones without parenting guidance<br>(2) Applications limited to managing children's screen time or scheduling without educational or behavioral components |

**Table 2. Inclusion and Exclusion Criteria for App Selection**

## 2.2. Design phase

### *2.2.1. Developing primary functions*

To develop the app's core functionalities, we mapped the selected behavioral objectives to relevant techniques from the Behavior Change Technique (BCT) Taxonomy v1[32]. This theory- and evidence-based framework was used to ensure that each function is aligned with validated

mechanisms of behavioral change. The identified BCTs were operationalized into specific app features to facilitate the intended user behaviors in real-world contexts.

#### *2.2.2. Designing user-friendly UX/UI*

To ensure a user-friendly interface design, we employed a UX/UI design tool to create wireframes that visualize the layout and structure of the application's core screens. Based on these wireframes, we developed the content flow from the perspective of end users, focusing on intuitive navigation, logical sequencing of features, and alignment with user needs. This approach will help create an app that effectively delivers its key functions and is easy for users to navigate.

### 2.3. Development phase

#### *2.3.1. Developing a beta version*

During the development phase, we work with a software company to ensure that the outputs from the previous analysis and design phases are accurately reflected in the beta version. In addition, we will ensure that server and data security are robustly established to protect users' sensitive information. The beta version will operate on both Android and iOS platforms, allowing it to be downloaded to mobile devices.

#### *2.3.2. Conducting expert validity verification*

Before conducting small-group user testing, the developed beta version will be distributed to experts for validity assessment. The expert group will comprise child and adolescent psychiatrists, parenting coaching specialists, and related experts. They will assess the app's validity and usability using the specialist version of the Mobile Device Application Rating Scale (MARS), a reliable quality rating scale for mobile health apps[33]. In addition, feedback will be collected through interviews with the experts to help identify any necessary modifications and areas for improvement. The compiled revisions will then be communicated to the development team to ensure that the beta version is updated accordingly prior to its release to the user group for testing.

#### *2.3.3. Testing a beta version with a small user group*

The updated beta version will be distributed to a small group of users comprising parents who are currently raising children with behavioral problems to gather feedback. The user group will engage with the beta version for three weeks, after which the participants will be asked questions related to whether the app has successfully achieved the implementation objective. The feedback obtained from these user interviews will be systematically analyzed to identify potential issues that require improvement within the app. Based on these insights, a user-centered beta version of the app will be developed for the implementation phase.

### 2.4. Implementation phase

#### *2.4.1. Conducting a pilot study*

The pilot test will employ a one-group pretest-posttest quasi-experimental design. The pilot group will comprise 12–30 caregivers raising children aged 3–5 years with behavioral challenges, as used in similar studies[34, 35]. We will recruit participants through convenience sampling via local child development and behavioral enhancement centers. After receiving an explanation of the study and providing their informed consent, the caregivers will participate voluntarily in the pilot study. We will provide participants with a clear description of how to navigate the app and its primary functions. Participants will then be required to complete a

structured questionnaire to assess their PSE, parenting style, and children's behavioral problems using the Korean version of the Parental Sense of Competence Scale (K-PSOC)[36], Korean-Parents as Social Context Questionnaire (K-PSCQ)[37], and Korean Eyeberg Child Behavior Inventory (K-ECBI)[38]. The pilot test will be conducted over a three-month period, during which we will collect data on app usage and document any issues encountered by users.

## 2.5. Evaluation phase

### *2.5.1. Evaluating the effectiveness of the application*

First, we will evaluate the efficacy of the mobile app on PSE, parenting style, and children's behavioral problems. Upon completion of the pilot test, the questionnaire will be readministered to facilitate comparison with the pre-test results. Statistical methods will be employed to identify changes in PSE, parenting style, and children's behavioral problems. Additionally, an effectiveness evaluation will be conducted using objective data obtained from app usage metrics, including the frequency of app usage, as well as the occurrence, duration, and severity of children's behavioral problems.

### *2.5.2. Conducting a user satisfaction survey*

Second, a user satisfaction survey will be conducted using the System Usability Scale, widely used for scaling user satisfaction[39]. Additionally, user interviews will include questions focused on the comprehensive user experience of the mobile app. Through this step, we aim to identify user satisfaction and areas for app modification or improvement.

## 3. Results

## 3.1. Analysis phase

A systematic search identified 160 relevant studies, from which 54 met the inclusion criteria and were reviewed in detail. This review highlighted the effectiveness of evidence-based parenting programs, specifically, Incredible Years, Triple P, Parent-Child Interaction Therapy (PCIT), and Parent Management Training (PMT), in reducing behavioral problems. These programs share a common theoretical foundation in social learning theory and consistently emphasize PSE as a core target for intervention. Accordingly, Bandura's self-efficacy theory was adopted as the theoretical framework for app development. Additionally, national guidelines issued by the Korea National Center for Mental Health were reviewed to ensure that the application design aligns with standardized principles for managing children's behavioral problems in Korea[40]. Five core benchmarking elements were extracted from the literature review: (1) content customization, (2) push notifications, (3) behavior tracking, (4) skill modeling through video demonstrations, and (5) reward systems[41-44]. These elements were mapped onto Bandura's four sources of self-efficacy to inform the app's design strategy.

The market analysis was conducted over a two-week period (January 15–29, 2025), during which 18 parenting-related mobile applications were reviewed using Bandura's self-efficacy theory as an analytical framework. Each app was evaluated based on the extent to which it addressed the four sources of self-efficacy: enactive mastery, vicarious experience, verbal persuasion, and physiological arousal (see Appendix 1).

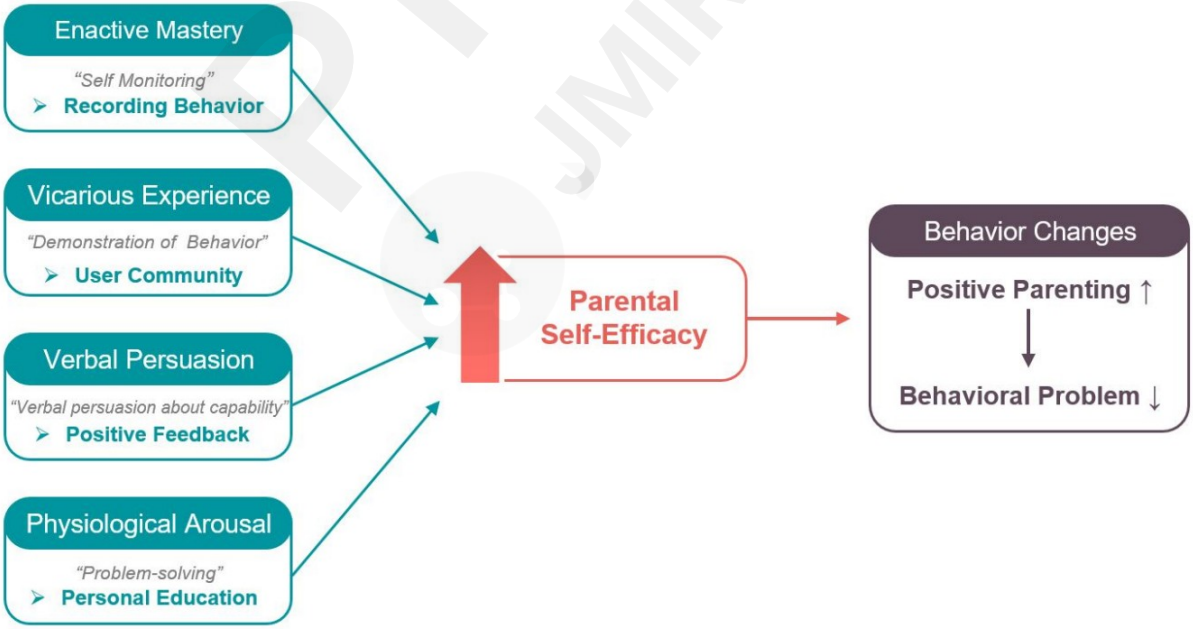
The comparative analysis revealed that only two applications incorporated all four components. For enactive mastery, five apps included behavior tracking features, and four provided diary functions. However, these tools primarily focused on general child activities

(e.g., chores, reading), rather than specifically targeting problematic behaviors. Regarding vicarious experience, three apps offered peer community forums, while six featured role-modeling through video demonstrations. Verbal persuasion was the most commonly addressed component; 15 apps provided educational content, and seven delivered push notifications as a means of reinforcing parenting efforts. For physiological arousal, only a few apps integrated relevant strategies, such as reward systems (n = 4), relaxation guidance (n = 3), and content customization (n = 7).

These findings highlight a substantial gap in the current market. Although many apps include partial elements of self-efficacy, few offer a comprehensive, theory-based intervention specifically designed to enhance parental self-efficacy in managing children's behavioral problems. To address this unmet need, our app was designed to incorporate all four sources of self-efficacy in an integrated manner. It distinguishes itself by focusing explicitly on problematic behaviors, applying behavior tracking to disruptive patterns, fostering peer learning through user communities, and enhancing emotional regulation via personalized support and rewards. This theory-driven differentiation positions the app as a unique and targeted digital intervention within the mHealth parenting landscape.

### 3.2. Design phase

The design phase focused on translating the outcomes of the analysis phase into concrete application features. The app's core functionalities were mapped to specific behavior change techniques aligned with the four elements of self-efficacy, considering the benchmarking elements and differentiation strategy. Figure 1 illustrates the overall structure of the app's primary functions grounded in Bandura's self-efficacy framework.




To support enactive mastery, the mobile app incorporated a "self-monitoring" technique by recording behavior, enabling users to track their parenting behaviors and their children's

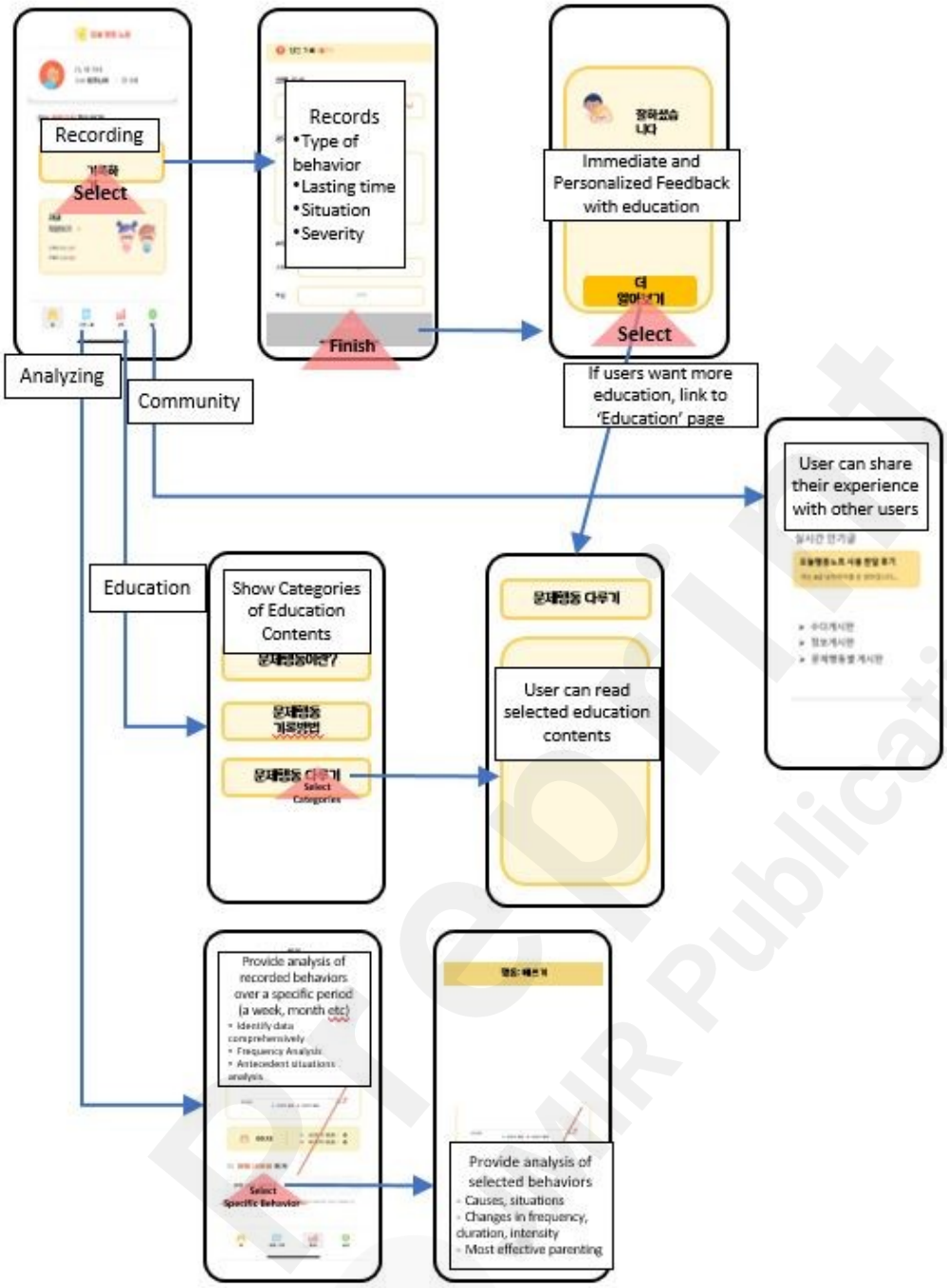
problem behaviors. “Self-monitoring” is widely regarded as an effective method for fostering a sense of accomplishment and success[45].

To facilitate vicarious experiences, the mobile app implemented the “demonstration of behavior” technique through a user community, where users can observe success stories shared by other parents. The “demonstration of behavior” method is effective for learning through observing others’ successes when executing tasks[45].

For verbal persuasion, the app incorporated a “verbal persuasion about capability” technique by providing users with positive feedback and push notifications[45]. These messages are designed to enhance users’ confidence in their parenting capabilities by providing personalized encouragement and reinforcement.

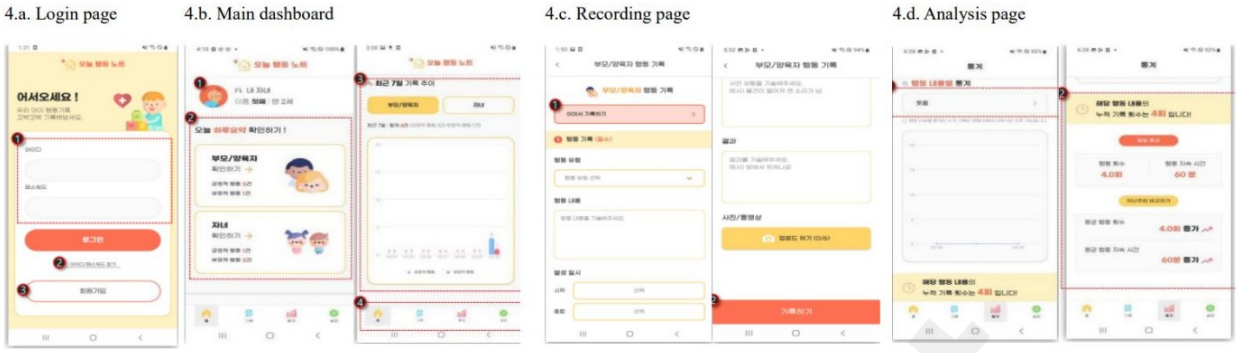
To enhance physiological arousal, the mobile app introduced a “problem-solving” technique by offering personalized education to help users manage stressful situations[45]. These modules offer tailored content based on users’ behavioral data, including AI-driven tips based on user profiles and behavior patterns.

In addition, the UX/UI design was developed, ensuring that the app’s layout, feature sequencing, and navigation align with end users’ needs (see Figure 3). The resulting application content flow reflects a logical progression from behavior tracking to feedback, personal education, and community, all of which are grounded in evidence-based behavior change techniques and aligned with the four self-efficacy components.




### 3.3. Development phase

The prototype was developed by using a prototyping tool to simulate the app's core functionalities. Figure 4 presents several user interface designs of the application. Figure 4.a. shows the main login screens that users encounter upon launching the app. Figure 4.b. displays the primary dashboard screen, which summarizes daily behavior records. Figure 4.c. illustrates the behavior recording interface, where users are required to input the type of behavior, its duration, intensity, the antecedent situation, and its consequences. Figure 4.d. presents the app's analytic feature, which visualizes behavior trends and allows users to compare the frequency of occurrence over time easily.




The development phase is currently underway in collaboration with a professional mobile application development company, reflecting the prototype. Upon completion of the beta version, the app will undergo the next planned steps: expert validity verification and testing with a small user group. These steps will provide essential feedback for refining the app before full-scale pilot implementation.

### 3.4. Implementation and Evaluation phase

Once the beta version of the mobile application is fully developed, the implementation and evaluation phases will be conducted. A pilot study is scheduled to be initiated in September 2025 to assess the app's feasibility, usability, and preliminary effectiveness. Results from these phases will be reported following the completion of the pilot test and data analysis.

## 4. Discussion

Given the significant impact of children's behavioral problems on both themselves and their families, effective parenting interventions are essential. The mobile application that we aim to develop is a promising tool for enhancing PSE, thereby fostering positive parenting practices that can effectively manage children's behavioral issues. Once the app's effectiveness has been robustly established, its usage will be expanded to a broader audience, including families of children with behavioral problems, healthcare facilities, and community settings.

To promote clinical adoption, partnerships with pediatric and behavioral health clinics will facilitate integration into therapy programs. Community engagement will involve collaborations with parenting organizations, NGOs, and advocacy groups. Webinars will educate families on the app's benefits, while targeted social media campaigns will raise awareness among parents and healthcare professionals. These efforts will ensure the app's broad accessibility and practical application.

Future efforts include developing multilingual versions of the app and conducting follow-up studies to assess long-term outcomes, ensuring sustainability and scalability. To implement these dissemination plans, we plan to recruit additional personnel to promote the app, ensure effective service delivery, and develop new features.

## Acknowledgements

This research was supported by the Brain Korea 21 FOUR Project funded by the National Research Foundation(NRF) of Korea, Yonsei University College of Nursing.

## Funding Statement
This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Conflicts of Interest
None declared.

## Author Contributions
AL conceived the app's development process and contributed to its conceptualization and functionality design. HL initiated the study design and drafted the initial research protocol. AL and HL critically reviewed and refined the protocol multiple times, providing critical revisions to ensure methodological rigor and coherence. All authors have read and approved the final version of the manuscript.

## Abbreviations
ADDIE model: Analysis, Design, Development, Implementation, and Evaluation model
ASD: Autism spectrum disorder
BCT: Behavior change technique
K-ECBI: Korean Eyeberg Child Behavior Inventory
K-PSCQ: Korean-Parents as Social Context Questionnaire
K-PSOC: Korean version of the Parental Sense of Competence Scale
MARS: Mobile Device Application Rating Scale
PCIT: Parent-Child Interaction Therapy
PMT: Parent Management Training

## References

1. Campbell SB. Behavior problems in preschool children: a review of recent research. J Child Psychol Psychiatry. 1995 Jan;36(1):113-49. PMID: 7714027. doi: 10.1111/j.1469-7610.1995.tb01657.x.
2. Jessor R, Jessor SL. Problem behavior and psychosocial development: A longitudinal study of youth. Academic Press; 1977.
3. Polanczyk GV, Salum GA, Sugaya LS, Caye A, Rohde LA. Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. J Child Psychol Psychiatry. 2015 Mar;56(3):345-65. PMID: 25649325. doi: 10.1111/jcpp.12381.
4. Lee K, Shin Y, Jeon Y, Park J. The Characteristics of Behavior Problem among Young Children in Korea. THE KOREAN JOURNAL OF DEVELOPMENTAL PSYCHOLOGY. 2004;17(4):53-74.
5. Simó-Pinatella D, Mumbardó-Adam C, Alomar-Kurz E, Sugai G, Simonsen B. Prevalence of Challenging Behaviors Exhibited by Children with Disabilities: Mapping the Literature. J Behav Educ. 2019 2019/09/01;28(3):323-43. doi: 10.1007/s10864-019-09326-9.
6. Mak MCK, Yin L, Li MH, Cheung RYH, Oon PT. The Relation between Parenting Stress and Child Behavior Problems: Negative Parenting Styles as Mediator. J Child Fam Stud. 2020 Nov;29(11):2993-3003. PMID: WOS:000553715400002. doi: 10.1007/s10826-020-01785-3.
7. Chen K-L, Iao L-S, Wu C-C. Impact of Child Behavior Problems on Parenting Stress and Depressive Symptoms Among Mothers of Children with Autism Spectrum Disorder: Mediation of Coping Strategies. J Dev Phys Disabil. 2023 2024/06/01;36(3):489-509. doi: 10.1007/s10882-023-09919-3.
8. Otto C, Kaman A, Erhart M, Barkmann C, Klasen F, Schlack R, et al. Risk and resource

factors of antisocial behaviour in children and adolescents: results of the longitudinal BELLA study. Child Adolesc Psychiatry Ment Health. 2021 2021/10/22;15(1):61. doi: 10.1186/s13034-021-00412-3.
9. Kim KH, Kwon HS, Kim HY, Park JS, Park CH, Lee JY, et al. A Study on the Structure of Social Costs of Adolescent Problem Behaviors. 2005.
10. Park IT, Oh W-O, Lee A. Changes in the Reciprocal Relationship Between Parenting and Self-Awareness During Adolescence: A Longitudinal Analysis of National Big Data. J Pediatr Nurs. 2019 2019/07/01/;47:e51-e7. doi: https://doi.org/10.1016/j.pedn.2019.04.025.
11. Lanjekar PD, Joshi SH, Lanjekar PD, Wagh V. The Effect of Parenting and the Parent-Child Relationship on a Child's Cognitive Development: A Literature Review. Cureus. 2022 Oct;14(10):e30574. PMID: 36420245. doi: 10.7759/cureus.30574.
12. Pinquart M. Associations of parenting dimensions and styles with externalizing problems of children and adolescents: An updated meta-analysis. Dev Psychol. 2017;53(5):873-932. doi: 10.1037/dev0000295.
13. Seay A, Freysteinson WM, McFarlane J. Positive Parenting. Nurs Forum. 2014;49(3):200-8. doi: https://doi.org/10.1111/nuf.12093.
14. Prime H, Andrews K, Markwell A, Gonzalez A, Janus M, Tricco AC, et al. Positive Parenting and Early Childhood Cognition: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Clin Child Fam Psychol Rev. 2023 Jun;26(2):362-400. PMID: 36729307. doi: 10.1007/s10567-022-00423-2.
15. Rishi P, John H. Efficacy of Positive Parenting Programme in Addressing ADHD Symptomatology and Parental Stress in Southern India. Psychol Stud (Mysore). 2024 2024/06/01;69(2):186-93. doi: 10.1007/s12646-024-00785-3.
16. Harpaz G, Grinshtain Y, Yaffe Y. Parental Self-Efficacy Predicted by Parents' Subjective Well-Being and Their Parenting Styles with Possible Role of Help-Seeking Orientation from Teachers. J Psychol. 2021;155(6):571-87. PMID: 34165397. doi: 10.1080/00223980.2021.1926896.
17. Bandura A. Self-efficacy : the exercise of control. New York: W.H. Freeman and Company; 1997. ISBN: 0716726262; 9780716726265; 0716728508; 9780716728504.
18. Jones TL, Prinz RJ. Potential roles of parental self-efficacy in parent and child adjustment: a review. Clin Psychol Rev. 2005 May;25(3):341-63. PMID: 15792853. doi: 10.1016/j.cpr.2004.12.004.
19. Hails KA, McWhirter AC, Garbacz SA, DeGarmo D, Caruthers AS, Stormshak EA, et al. Parenting self-efficacy in relation to the family check-up's effect on elementary school children's behavior. J Fam Psychol. 2024 Sep;38(6):858-68. PMID: 38780604. doi: 10.1037/fam0001237.
20. Weber L, Kamp-Becker I, Christiansen H, Mingebach T. Treatment of child externalizing behavior problems: a comprehensive review and meta-meta-analysis on effects of parent-based interventions on parental characteristics. Eur Child Adolesc Psychiatry. 2019 Aug;28(8):1025-36. PMID: 29948228. doi: 10.1007/s00787-018-1175-3.
21. David OA, Iuga IA, Miron IS. Parenting: There is an app for that. A systematic review of parenting interventions apps. Child Youth Serv Rev. 2024 2024/01/01/;156:107385. doi: https://doi.org/10.1016/j.childyouth.2023.107385.
22. Li K, Magnuson KI, Beuley G, Davis L, Ryan-Pettes SR. Features, Design, and Adherence to Evidence-Based Behavioral Parenting Principles in Commercial mHealth Parenting Apps: Systematic Review. JMIR Pediatr Parent. 2023 Jun 1;6:e43626. PMID: 37261886. doi: 10.2196/43626.
23. GSMA. Global smartphone penetration rate as share of population from 2016 to 2023 [Graph]. In Statista.: In Statista.; 2024 [cited 2024 November 22]; Available from:

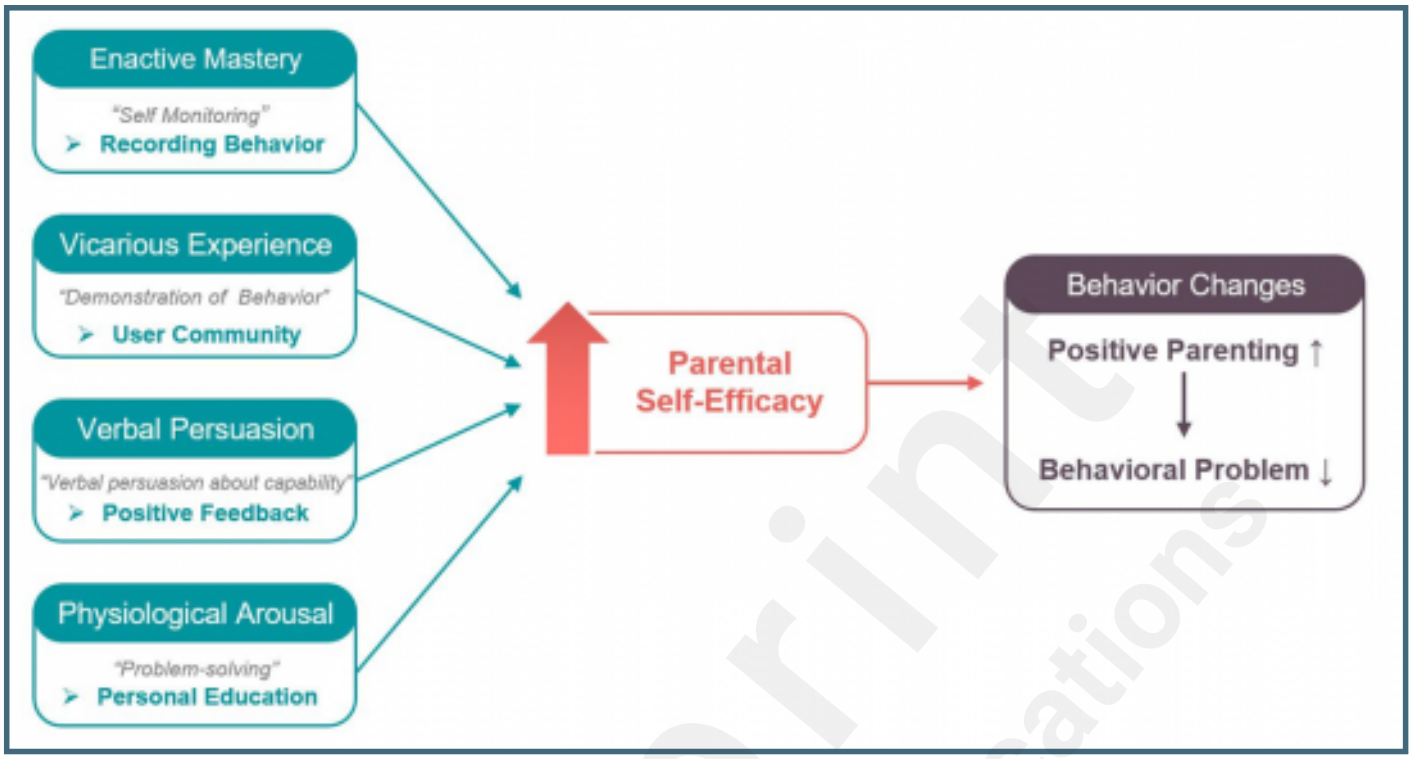
https://www.statista.com/statistics/203734/global-smartphone-penetration-per-capita-since-2005.
24. Jeong. Y, Kim. Y, Oh. Y. Korea Media Panel Survey. In: Institute. KISD, editor. 2023.
25. Rowe JP, Lester JC. Artificial Intelligence for Personalized Preventive Adolescent Healthcare. J Adolesc Health. 2020 Aug;67(2s):S52-s8. PMID: 32718516. doi: 10.1016/j.jadohealth.2020.02.021.
26. O'Connor S, Yan Y, Thilo FJS, Felzmann H, Dowding D, Lee JJ. Artificial intelligence in nursing and midwifery: A systematic review. J Clin Nurs. 2023 2023/07/01;32(13-14):2951-68. doi: https://doi.org/10.1111/jocn.16478.
27. Branch R. Instructional design: The ADDIE approach. Springer; 2009.
28. Allen WC. Overview and Evolution of the ADDIE Training System. Adv Dev Hum Resour. 2006;8(4):430-41. doi: 10.1177/1523422306292942.
29. Aydin A, Gürsoy A, Karal H. Mobile care app development process: using the ADDIE model to manage symptoms after breast cancer surgery (step 1). Discover Oncology. 2023 2023/05/09;14(1):63. doi: 10.1007/s12672-023-00676-5.
30. LaMarca VJ, LaMarca JM. Using the ADDIE Model of Instructional Design to Create Programming for Comprehensive ABA Treatment. Behav Anal Pract. 2024 2024/06/01;17(2):371-88. doi: 10.1007/s40617-024-00908-2.
31. Agarwal S, LeFevre AE, Lee J, L'Engle K, Mehl G, Sinha C, et al. Guidelines for reporting of health interventions using mobile phones: mobile health (mHealth) evidence reporting and assessment (mERA) checklist. BMJ. 2016;352:i1174. doi: 10.1136/bmj.i1174.
32. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med. 2013 Aug;46(1):81-95. PMID: 23512568. doi: 10.1007/s12160-013-9486-6.
33. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. JMIR Mhealth Uhealth. 2015 Mar 11;3(1):e27. PMID: 25760773. doi: 10.2196/mhealth.3422.
34. Fisher AP, Miley AE, Glazer S, Gies LM, Parikh NA, Lam L, et al. Feasibility and acceptability of an online parenting intervention to address behaviour problems in moderately to extremely preterm pre-school and school-age children. Child Care Health Dev. 2024 Jan;50(1):e13209. PMID: 38100158. doi: 10.1111/cch.13209.
35. Julious SA. Sample size of 12 per group rule of thumb for a pilot study. Pharm Stat. 2005;4(4):287-91. doi: https://doi.org/10.1002/pst.185.
36. Jeongmee K, Heesun L, Sungho H. A Validation Study of the Korean version of the Parenting Sense of Competence and the Parenting Alliance Inventory. The Korean Journal of Developmental Psychology. 2014;27(2):1-21.
37. Gyo Young J, Hee Cheon S. Validation of the Korean Version of Parents as Social Context Questionnaire(PSCQ). Korea J Couns. 2011;12(4):1287-305.
38. Rhee ER, Rhee ES. Psychometric Properties and Standardization of the Korean Version of the Eyberg Child Behavior Inventory. J Child Fam Stud. 2015;24(8):2453. PMID: edssjs.E5988795.
39. Brooke J. SUS-A quick and dirty usability scale. Usability evaluation in industry. 1996;189(194):4-7.
40. Psychology. YUDo. Standard guidelines and treatment manual for problem behaviors. Seoul (Korea): National Center for Mental Health, 2018.
41. Baumel A, Pawar A, Mathur N, Kane JM, Correll CU. Technology-Assisted Parent Training Programs for Children and Adolescents With Disruptive Behaviors: A Systematic Review. J Clin Psychiatry. 2017 Sep/Oct;78(8):e957-e69. PMID: 28493653. doi: 10.4088/JCP.16r11063.

42. Dishion T, Forgatch M, Chamberlain P, Pelham WE, 3rd. The Oregon Model of Behavior Family Therapy: From Intervention Design to Promoting Large-Scale System Change. Behav Ther. 2016 Nov;47(6):812-37. PMID: 27993335. doi: 10.1016/j.beth.2016.02.002.
43. Grube WA, Liming KW. Attachment and Biobehavioral Catch-Up: A Systematic Review. Infant Ment Health J. 2018 Nov;39(6):656-73. PMID: 30365173. doi: 10.1002/imhj.21745.
44. Magnuson KI, Li K, Beuley G, Ryan-Pettes SR. The Use of Noncommercial Parent-Focused mHealth Interventions for Behavioral Problems in Youth: Systematic Review. JMIR Mhealth Uhealth. 2024 Sep 24;12:e51273. PMID: 39316435. doi: 10.2196/51273.
45. Warner LM, French DP. Self-Efficacy Interventions. In: Hagger MS, Cameron LD, Hamilton K, Hankonen N, Lintunen T, editors. The Handbook of Behavior Change. Cambridge: Cambridge University Press; 2020. p. 461-78.

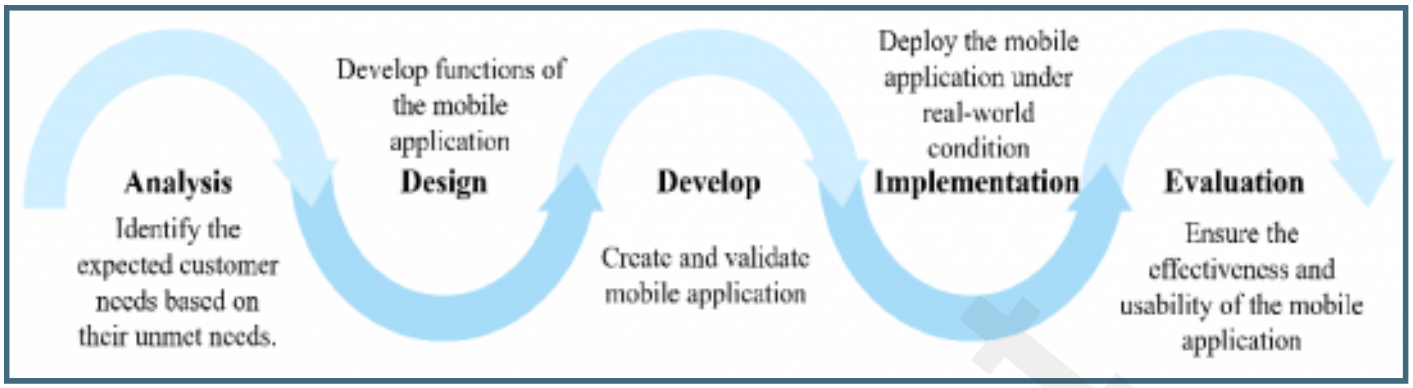
# Supplementary Files

# Figures

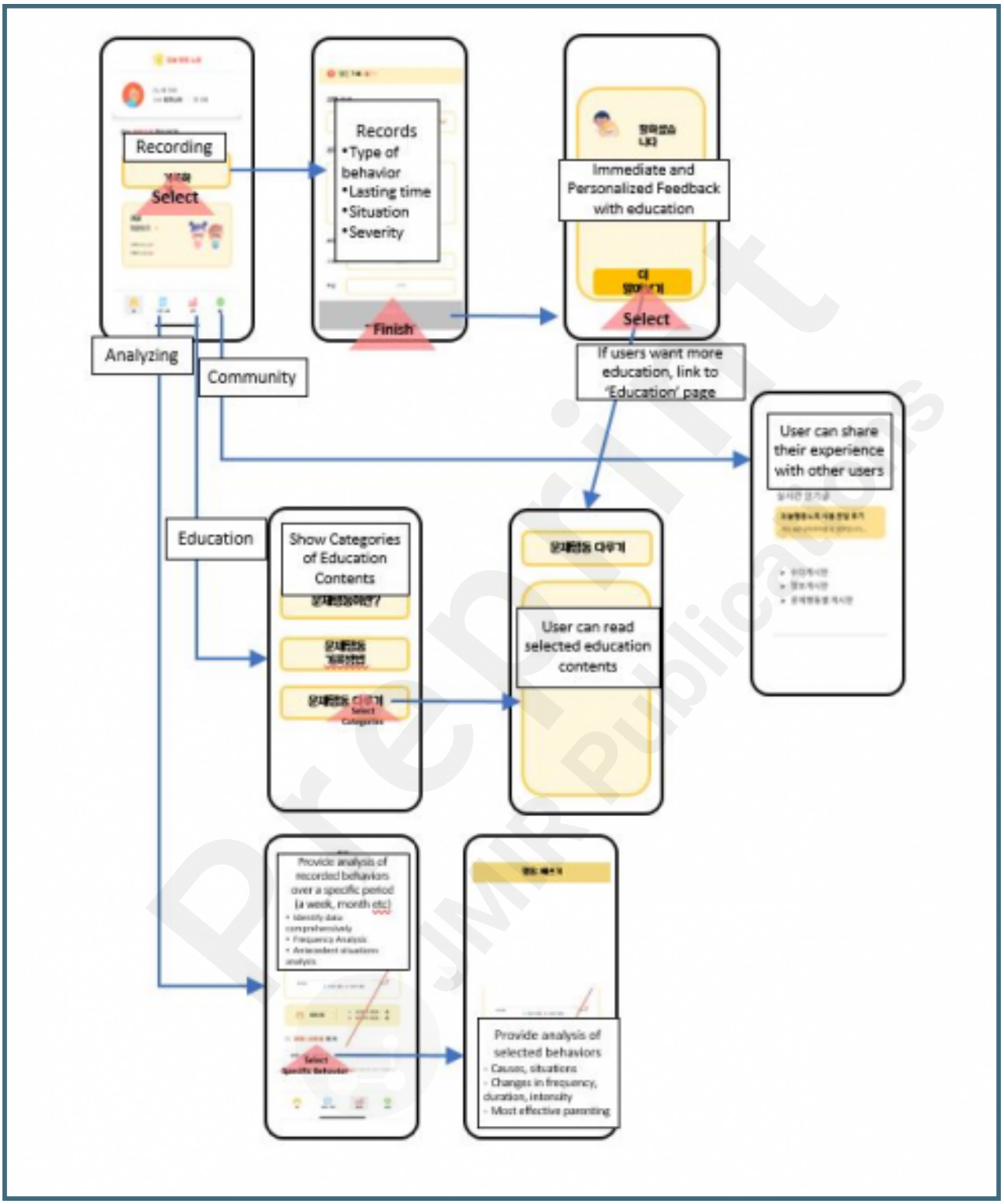
Outline of the Mobile Application based on Bandura's Self-Efficacy Theory.



The ADDIE model based on the study objectives.



Example of content flow.



Prototype of the app.

# Multimedia Appendixes

Comparison of parenting apps based on the four sources of Bandura's self-efficacy theory.
URL: http://asset.jmir.pub/assets/4f8a469ed7d98f9c9ba8d3bd142a8124.docx