WePilot: Integrating Younger Family Members and Chatbot to Support Older Adults Learning Smartphone Usage

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Older adults (OAs) usually face various challenges when using smartphones due to their limited knowledge and the declines in memory and information processing capabilities. Many studies in HCI and CSCW communities have focused on supporting OAs to independently use smartphones. However, compared to independent exploration, support from younger family members (YFMs) has specific advantages in problem understanding, solution personalization, and security protection. However, OAs and YFMs generally have gaps in time, knowledge, and experience, affecting the efficiency of support and their experience. For this problem, we conduct a formative study to gather insights into OAs and YFMs' perspectives and expectations in the supporting procedure. Then we introduce chatbot to mediate the gaps between OAs and YFMs and build a system named WePilot to assist them to collaboratively solve smartphone usage problems. Evaluations with 12 pairs of participants (OA and corresponding YFM) suggest WePilot's strengths in improving problem solving efficiency and OAs and YFMs' experience. Based on these findings, we propose several insights into the future design of intergenerational technical support systems.

CCS Concepts: • **Human-centered computing → Collaborative and social computing**.

Additional Key Words and Phrases: intergenerational technical support, chatbot-mediated collaboration, smartphone usage, older adults, younger family members

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1 Introduction

Nowadays, a growing number of older adults (OAs) have started to use smartphones for communication and entertainment[4, 48, 54, 62]. However, due to their limited knowledge and experience in Information and Communication Technology (ICT) use, and the declines in memory and information processing, OAs usually face various challenges when using smartphones[45, 48, 63]. Smartphone tasks such as online shopping, booking transportation, and paying bills, which are common practices for young adults, are generally difficult for OAs, prompting them to seek different external help. Existing research demonstrates that OAs tend to rely on informal sources of support such as family members, children, and community volunteers rather than formal online or offline courses. This tendency persists even when there are temporal or spatial mismatches between the OAs and the supporters[4, 36, 62]. For instance, in situations where OAs and their children live separately, the OAs frequently ask their children to provide support via phone or video call to address issues related to smartphone usage.

In recent years, many studies in HCI and CSCW communities have focused on supporting OAs to independently use smartphones[52, 102]. However, compared to independent exploration, support from younger family members (YFMs) has several advantages in enhancing the technological adaptability and improving the efficiency of problem solving[2, 32, 99]. Firstly, YFMs' familiarity with OAs' life habits and digital literacy enables them to quickly identify and address challenges that OAs face, leading to a more personalized and efficient support process[5, 37, 49]. Secondly, in online environment, OAs are exposed to various digital risks such as privacy breaches and financial scams. YFMs' support and guidance can improve the safety and security of OAs during smartphone usage[56, 68, 86]. Finally, YFMs' involvement and support for problem solving is also a scenario for intergenerational communication, helping strengthen emotional bonds between OAs and YFMs, especially when they live in different cities[13, 21, 41, 57].

Despite these advantages, YFM-supported smartphone usage faces several prominent challenges in reality[2, 36, 39]. Firstly, there is generally misalignment of schedules between OAs and YFMs, as YFMs need to engage in their own daily activities, making their support often belated for OAs. Secondly, OAs typically seek detailed and step-by-step guidance to ensure comprehension and following, while YFMs usually just give simple instructions due to time constraint or the belief that OAs do not need to master details, weakening the quality of support. Thirdly, although YFMs generally have higher digital literacy, they may still encounter knowledge gaps. For instance, some applications or functionalities that OAs prefer to use may be unfamiliar to YFMs, hindering YFMs' ability to respond to OAs' requests. Over time, these challenges could not only aggravate the psychological burden of OAs when seeking help but also reduce YFMs' motivation to continue offering support.

For these challenges, it is emergent to investigate how to promote the quality and effectiveness of YFM-supported smartphone usage for OAs. Drawing inspiration from various relevant studies in HCI and CSCW fields, such as research on improving parent-child relationships through joint learning[31, 105], family-assisted models in telemedicine[6, 18, 24], and collaboration on technology use[12, 76], we propose incorporating chatbots into the help-seeking interactions between OAs and YFMs. Chatbots are characterized with several specific features to address the above challenges. Firstly, chatbots are always available, allowing them to fast respond to OAs' issues and lessen the burden on YFMs. Secondly, chatbots can interact with OAs through natural languages, offering fine-grained guidance according to user preferences. Furthermore, trained on large-scale corpus, chatbots can respond to a broader range of problems, compensating for YFMs' knowledge about smartphone usage and enhancing the overall efficiency and effectiveness of the help-seeking process.

Building on this foundation, we aim to explore how to introduce chatbots into the procedure of YFM-supported smartphone usage to bridge the mentioned gaps between OAs and YFMs. Initially, we conduct a formative study to gather insights into OAs and YFMs' perspectives and expectations in the supporting procedure, especially their gaps that chatbots are expected to mediate. Then we propose four goals to guide our system design, including enhancing support for OAs while reducing the workload of YFMs, enhancing OAs' experience through flexible guidance and feedback, expanding YFMs' problem-solving capabilities but reducing workload, and maintaining participation of OAs and YFMs. Second, we present a chatbot-mediated system named WePilot to facilitate YFM-supported smartphone usage for OAs. It is essentially a chatbot-based tool with modules of Solution Finding, Operation Guiding, and Feedback. The Solution Finding module collaborates with YFMs to find solutions through two flexible modes, YFM-lead and Agent-lead, addressing YFMs' knowledge limitations while reducing their time and efforts spent in solution finding. In addition, the reuse mechanism is also considered in this module to respond to OAs' repeated problems effectively. Once a solution is obtained, the Operation Guiding module provides OAs with two forms of operation guidance to accommodate different problem types, *step-by-step* and *one-click-go*, meeting OAs' expectations for intuitive and highly interactive support. The Feedback module tracks OAs' progress in problem-solving and presents it to YFMs, maintaining YFMs' proper perception and sense of control. Third, we implement WePilot as a prototype and recruit 12 pairs of participants (OA and corresponding YFM) for evaluation. The evaluation results suggest WePilot's significant improvements, e.g., reducing YFMs' time cost by 42% and providing more intuitive, natural, and efficient support experiences for OAs. Based on these findings, we propose several insights into the future design of intergenerational technical support systems or tools, such as preventing security risks, balancing automation and learning, and enhancing expression consistency and personalization. To conclude, our contributions can be summarized as:

- To the best of our knowledge, this is the first work on investigating chatbot-mediated systems to promote YFM-supported smartphone usage for OAs.
- We conduct a formative study to analyze OAs and YFMs' perspectives and expectations in the supporting procedure, based on which we propose four strategies to guide our system design.
- We propose a chatbot-mediated system to assist OAs and YFMs to collaboratively solve smartphone usage problems. Extensive evaluations are also conducted in real scenarios to reveal WePilot's strengths and weakness.
- Several insights are proposed for the further research and design of remote intergenerational technical support systems.

The rest of this paper is organized as follows. In Section 2, we review related research. Section 3 introduces the procedure and results of our formative study. In Section 4, the framework of WePilot and its implementation are given. Section 5 exhibits our evaluation results. Section 6 discusses our findings, the limitations, and future work. Finally, conclusions are given in Section 7.

2 Related Work

2.1 Challenges and Preferences of Older Adults in Learning Smartphone Usage

In recent years, a growing number of OAs have started to use smartphones in their daily lives to improve social participation [4, 48, 54, 62]. Although they are generally willing to engage with new technologies, they often encounter cognitive, physical, and motivational challenges when using smartphones[54, 63]. From the perspective of cognition, declines in memory and information processing abilities make it difficult for them to recall operation steps[48, 55]. In addition, physical limitations such as reduced vision, hearing, and dexterity further complicate their interactions with small screens and touch devices [21, 60, 63]. Moreover, some OAs struggle to maintain motivation to learn new technologies, particularly after experiencing repeated failures [21]. These challenges often lead to feelings of frustration and anxiety during smartphone learning and usage, which in turn reduces their willingness to adopt new technologies [40].

In light of these challenges, OAs exhibit varying preferences in learning smartphone usage. Studies indicate that they typically adopt two primary learning methods: self-exploration and social learning [73]. Self-exploration involves independently exploring applications, using online websites or video tutorials, consulting instruction manuals, or referring to help menus [48]. In contrast, social learning occurs through interactions with others, such as family members, friends, or colleagues[21, 57, 86]. Research has found that many OAs prefer to learn independently, in part because they hesitate to disturb others or worry about making embarrassing mistakes [39, 52]. Although they seek help through manuals or video tutorials during independent learning, this approach often makes them confused, primarily because they often struggle to map tutorial instructions to actual operations[2, 53].

However, if the concern of disturbing others is alleviated, OAs tend to rely less on traditional instruction manuals and instead favor human support and flexible learning methods[4, 36, 62]. When encountering issues, they typically turn to family and friends for social support. Studies, such as [57, 68], have shown that social support not only provides more immediate feedback and personalized solutions, but also increases their confidence through interactions with others. Nevertheless, such support is not always available, as the availability of supporters is often constrained by factors such as time and distance [2, 39, 55]. Therefore, while OAs are eager to receive social support, improving the availability of such support continues to be a significant challenge.

2.2 Current Approaches to Supporting Older Adults' Smartphone Usage

Previous research has made significant efforts to support software newcomers, including OAs. As mentioned earlier, the existing support methods correspond to the two primary learning approaches commonly adopted by OAs[73]: supporting OAs independently learning instructional materials and facilitating OAs' access to social support.

First, research on supporting OAs in learning smartphone usage through tutorials has become a focus in HCI and CSCW fields in recent years. Many studies aim to enhance OAs' self-learning by improving the interactive experience or presentation of tutorials. For example, Pongnumkul et al. developed a tool that automatically pauses and plays video tutorials when OAs watch them[67]; the tool named HelpViz automatically integrates text instructions with screenshots to generate multimedia tutorials[106]; the system named MixT automatically combines text instructions with demonstration videos to produce step-by-step guidelines [16]. These tutorials, which combine text, images, and videos, provide users with step-by-step instructions to help them understand complex tasks. However, despite simplifying operations, this "step-by-step guiding" procedure can still be difficult for OAs to follow and process [53]. As a result, recent research has begun exploring the use of interactive tutorials that provide visual[2, 39, 90] and/or audio prompts[55, 98] within the target application to guide users more directly. For example, [39] developed the first interactive tutorial system for OAs, allowing them to learn tasks through a trial-and-error approach. Following this, studies[102, 103] have further explored ways to help OAs locate relevant icons in the current interface, while [23] proposed a technique to help OAs in better formulating queries. However, these methods of supporting independent smartphone usage among OAs face some inherent problems. For example, it is challenging for these automated systems/tools to comprehend OAs' intent due to OAs' lack of ICT experience and nonstandard expressions. OAs' independent exploration with trial-and-error can also lead to incorrect operations, aggravating privacy and security risks.

In contrast, research on assisting OAs in accessing social support has gained increasing attention. Previous studies have found that remote support often causes communication issues due to the lack of a shared visual environment (i.e., supporters cannot see the seekers' screen)[2]. Consequently, researchers have sought to reduce communication barriers by improving existing remote communication methods. For instance, Tanprasert proposed the HelpCall system, enabling children to help OAs with ICT issues via video calls[87]. Similarly, [39] presented a method to allow the supporter to perform a demonstration on their own phone, which is then replicated as a tutorial on the OAs' device. However, these approaches primarily focus on OAs' experiences and expectations, often neglecting supporters' feelings and gaps, such as their knowledge limitations and time constraints.

Our research aims to bridge this gap by designing a system that supports OAs' learning while reducing the burden on YFMs. The system will combine the advantages of automated tutorials and social support, providing interactive guidance and assistance to ensure OAs can complete tasks smoothly. At the same time, automated tutorials will take part of the YFMs' responsibilities, thereby improving the effectiveness and efficiency of support and reducing their burdens in the meanwhile.

2.3 Chatbot-mediated Interaction/Collaboration

Recent research has demonstrated the potential of chatbots in facilitating communication and collaboration among individuals[76, 77, 91]. In human conversations[78], chatbots can be utilized to collect deeper and higher-quality information to enhance user engagement [44]. For instance, Rhim et al.'s study employed human-centered design to leverage chatbots to effectively improve both user interaction and data collection quality [69]. In the context of complex task collaboration, chatbots are widely used to support co-design and online discussions [30, 64]. By intelligently managing conversation flow, synchronizing perspectives, and providing real-time feedback, chatbots can effectively promote team communication and decision-making [43]. In particular in remote and asynchronous collaboration scenarios, chatbots demonstrate prominent advantages in helping users overcome temporal and spatial limitations to coordinate complex tasks [46]. These studies suggest that chatbots are not merely simple conversational tools but can serve as intelligent mediators that facilitate complex collaboration.

Chatbots also show significant potential and unique value in enhancing family interactions. Research indicates that by introducing chatbots as interactive mediators, communication efficiency and emotional bonds among family members are significantly strengthened [101]. For example, the StoryBuddy system demonstrated how chatbots can enhance intergenerational interaction through shared reading experiences, providing insights into strengthening parent-child relationships during storytelling [105]. In broader social connection scenarios, research by Lee et al. illustrates how chatbots can effectively promote interactions among residents in shared living spaces by facilitating intelligent information sharing, thereby enhancing a sense of connection and belonging among community members[64]. These studies reveal that chatbots can provide support beyond technical functions, serving as effective tools for interpersonal connection. Through flexible scheduling and personalized interaction support, chatbots can reduce communication burdens and create richer and more meaningful social interaction experiences.

However, chatbot systems specifically designed for remote intergenerational technical support between OAs and YFMs remain scarce. Existing research mainly focuses on general communication [51, 64, 91], with limited exploration of how chatbots can be used to optimize intergenerational collaborative ICT learning and remote support. To address this gap, our research explores the design of a chatbot-mediated system to promote the effectiveness and efficiency of YFM-supported smartphone usage, providing a novel solution to bridge the gaps between OAs and YFMs in addressing smartphone usage problems.

3 Formative Study

3.1 Process

We conducted a formative study to explore remote intergenerational technical support between OAs and YFMs in scenarios involving smartphone usage issues.

3.1.1 Participants. We recruited participants through offline communities and online platforms, followed by a screening survey. The inclusion criteria for OAs were as follows: (1) 55 years or older; (2) having a smartphone with at least daily usage; (3) having not known and experienced complex features of the smartphone or APPs, such as clearing cache or paying bills online; (4) having the ability to participate in our study; and (5) having the experience of seeking help from YFMs to solve smartphone usage issues. For YFMs, the selection criteria included: (1) having experience in supporting an older adult (aged 55 or older) with smartphone usage issues; and (2) having availability to join in our study. Since our formative study does not involve collaboration tasks between OAs and YFMs, we didn't recruit coupled participants, i.e., the pair of OA and the corresponding YFM. We received responses from 14 OAs and 10 YFMs, and after screening, 11 OA and 10 YFM participants were obtained. Detailed demographic information of the participants is shown in Tables 1 and 2. From Table 2, we could see that YFMs reported being asked for help at different times per month. We did not consider the frequency of requested help as a screening criterion since it can help observe YFMs' experiences and requirements (e.g., perceived burden) under different scenarios.

Table 1. Demographics and smartphone usage information in Formative Study of OAs. "F" represents "Female", and "M" represents "Male".

ID	Age	Gender	Level of Education	Years of Smartphone Usage
OA1	68	F	Senior High School	14
OA2	63	F	Primary School or Below	7
OA3	70	F	Bachelor's Degree	8
OA4	77	M	Bachelor's Degree	16
OA5	78	M	Bachelor's Degree	14
OA6	75	M	Junior High School	3
OA7	78	F	Associate Degree	10
OA8	70	F	Senior High School	7
OA9	62	M	Senior High School	5
OA10	66	F	Senior High School	11
OA11	62	F	Primary School or Below	10

3.1.2 Procedure and Data Analysis. Each session of our formative study involved a one-on-one offline interview lasting 40 minutes. Drawing on [25, 35, 61, 97], participants first reviewed a sketch-based prototype, which prioritized the interactions between users and the chatbot rather than interface details [3, 27, 105]. This approach was inspired by Carroll's scenario-based design principles [14], emphasizing user interactions and feedback to refine the system. The prototype focused on two key aspects: interaction features between YFMs and the assistant (e.g., the roles they play, the content exchanged and presentation) and the interaction features between OAs and the assistant (e.g., the degree of guidance, the modality in communication).

All sessions were audio-recorded with participants' consent, transcribed using automated tools and then verified by the first author. We also noted participants' emotional expressions (e.g., "tired",

Table 2. Demographics and requested help information in Formative Study of Younger Adults(YAs). “F” represents “Female”, and “M” represents “Male”.

ID	Age	Gender	Status	Recipient of Help	Frequency of Requested Help
YA1	26	M	Student	Grandparents	3-5/month
YA2	26	M	Student	Grandparents	<3/month
YA3	29	F	Employee	Parents and Grandparents	3-5/month
YA4	33	M	Employee	Parents	3-5/month
YA5	39	M	Employee	Parents	6-8/month
YA6	24	F	Student	Grandparents	3-5/month
YA7	42	M	Employee	Parents	<3/month
YA8	23	F	Student	Grandparents	<3/month
YA9	22	F	Student	Grandparents	3-5/month
YA10	34	F	Employee	Grandparents	3-5/month

“exhausted”) and signals (e.g., sighs, hesitation pauses) during transcription[15, 58]. We used Braun and Clarke’s thematic analysis method to code the interview transcripts [9], following the six steps described in codebook-based thematic analysis [10, 11]. First, three authors independently read all the transcripts several times to familiarize themselves with the content and identify key concepts, themes, and patterns. Then, they conducted open coding and created an initial list of codes that identified relevant themes emerging from the data. These early codes were then grouped into larger themes that matched the research goals. Next, the authors reviewed and refined the themes together, removing weak or repeated themes and adding subthemes when needed. Each theme was clearly described, supported by data examples, and named to summarize its essence. Once the themes were finalized, the authors reviewed the data again to apply the codes fully and chose strong examples to support the findings. Although the six phases are presented in a logical sequence, they are not strictly one-directional. Instead, the above procedure is recursive and iterative, requiring the authors to move back and forth between phases as necessary. Regular communications and collaborative reviews were kept throughout the process to ensure transparency, accuracy, and reliability. The coding process ended when all authors reached a consensus on the final themes.

We aimed to uncover: (1) decision model for solving smartphone usage problem with YFM support; (2) specific issues within the model; and (3) the expectations of both YFMs and OAs for addressing these issues. During the interview, participants were encouraged to share their experiences, the challenges they encountered, and their feedback and expectations for a support tool.

3.2 Findings

3.2.1 F1: Factors influencing the provision of support. To systematically uncover this decision-making process, we synthesized interview data with the ethnographic decision model proposed by [68], obtaining a decision model tailored to describe how YFMs support OAs with smartphone usage. We present the decision-making process in Figure 1.

Problem Complexity. YFMs are motivated by a sense of familial responsibility and filial piety, which stimulates them to provide solutions. They first assess the complexity of the issue. If the problem lies beyond their knowledge, they opt not to offer support. For example, YA3 stated, “*Their (OAs) proficiency level is lower than mine, ... I’d assume it’s probably not a reliable app.*”

Problem Type. Once YFMs decide to provide support, the type of issue determines the form of support. We categorized issues as either configuration-related problems or operation-related

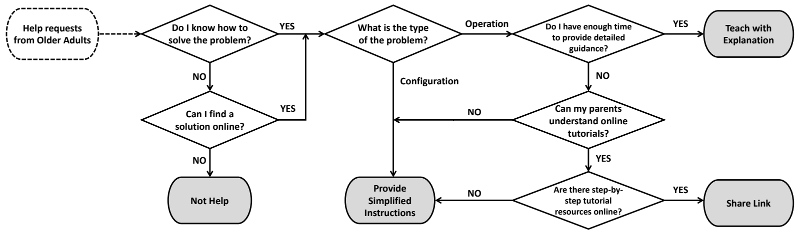

Fig. 1. Decision flowchart for YFMs processing smartphone help requests from OAs.

problems. Configuration-related problems are solution-oriented and involve one-time setups, such as creating accounts or setting language input methods. In contrast, operation-related problems are learning-oriented and occur more frequently in OAs' daily smartphone usage, such as posting on social media or shopping on an e-commerce platform. YA1 mentioned, "*I think my parents don't need to learn some operations, like enabling the voice announcement switch. It only needs to be turned on once.*" For configuration-related problems, YFMs tend to guide OAs through simplified operation instructions (e.g., "*Tap the plus sign in the top right corner*") to help them solve the problems. In contrast, for operation-related problems, YFMs teach OAs through detailed explanations (e.g., "*The plus icon is like a drawer where some features are stored*") to help them understand and remember the process, reducing repeated requests for help.

Time Consumption. Providing detailed explanations requires more free time than giving simplified operation instructions. YFMs shared experiences of receiving support requests from their parents during busy periods. For instance, YA5 said "*Sometimes when I am in a meeting, my phone buzzes with a WeChat message from my mom, asking 'How do I ...?' Moments like this can be distracting.*"

Consequently, when confronted with operation-related problems, YFMs first consider the time needed to solve the problems against their current availability. If YFMs are short on time, a step-by-step teaching approach will not be considered. In such cases, online tutorials (e.g., text or video guides) are a more time-efficient alternative. However, due to the varying levels of digital literacy among OAs and the lack of comprehensive online tutorials, YFMs resort to simplified instructions instead. As YA10 explained, "*When I don't have enough time, I just let them follow my step-by-step instructions to solve it first.*" When YFMs have sufficient time, they prioritize providing detailed explanations to help their parents.

Beside the time needed for solving a request, the frequency of being asked for help can also affect YFMs' perceived burden and willingness to provide support. For instance, our analysis of interview transcripts revealed that when sharing experiences of receiving support requests from parents, the YFMs asked for help 6-8/month used 2.7 times more negative emotion words (e.g., "frustrating", "exhausted") than YFMs asked for <3/month, indicating frequency qualifies as burdensome for YFMs.

3.2.2 F2: Problems with Current Model. The difficulties in smartphone assistance stem from both gaps between OAs and YFMs as well as their specific limitations.

Gaps between OAs and YFMs:

- ***Digital Literacy Misalignment.*** A significant barrier is the disparity in digital literacy between OAs and YFMs. When YFMs attempt to explain ICT-related concepts, OAs struggle to grasp terms such as "cache" or "cloud storage." This challenge is amplified when YFMs have a technical background, as they prefer to use technical jargon in communication, while OAs face difficulties in understanding these terms. So, YFMs need to provide detailed explanations and adjust their teaching strategies based on OAs' knowledge level. This involves simplifying their language during explanations and considering the most effective ways to express concepts to enhance memorization. As YA7 expressed: "*The problem is they often forget. I teach them once, and they don't get it; then I teach them again, and still, they don't get it.*"

- ***Belated Response and Feedback.*** OAs are usually unable to receive timely support when YFMs cannot respond immediately due to time or distance constraints. OAs may feel that they "*still haven't known how to do it*" (OA5), negatively impacting their confidence and willingness to use new technologies in the future. Even responding to OAs' requests, YFMs are generally unable to monitor OAs' operations in real-time. OAs may unknowingly make wrong operations or navigate to the wrong screen and realize their mistakes after several steps. The lack of YFMs' feedback results in time-wasting and frustration for both parties.
- ***Difference in Device Interfaces.*** Due to differences in operating systems used by OAs and YFMs, YFMs struggle to describe the steps OAs need to take accurately. These interface discrepancies hinder the synchronization of their actions. In the meanwhile, they must infer potential issues and offer corresponding instructions.

Role-Specific Challenges:

- ***OAs' Instruction Following and Operating Limitations.*** We found it is generally challenging for OAs to map YFMs' voice descriptions of screen elements onto their own devices, such as "*tap the plus sign.*" This leads to errors, particularly in feature-rich interfaces. We thought this challenge mainly stems from their limited adaptability to new technologies and declines in physical and cognitive abilities, such as reduced cognitive flexibility, visual impairments, and diminished motor coordination.
- ***YFMs' Knowledge and Resource Limitations.*** For YFMs, even if they understand the OAs' issue, they struggle to find an immediate solution if the issue exceeds their knowledge. YFMs may need to search for external resources or seek help from others. YA4 shared an experience where his mother requested help with a health insurance payment issue, "*I wasn't familiar with [that platform]. So, I had to look it up online myself before explaining it to her.*" This not only increased the time cost but also added extra workload.

3.2.3 F3: Expectations and Conflicts of Different Stakeholders. We further investigated OAs and YFMs' expectations for an ideal remote technical support system. We synthesized insights from both perspectives and compared the potential conflicts in their expectations.

Expectations of OAs. The expectations of OAs focus on improving support experience and reducing cognitive load, including improving the accessibility of support, providing intuitive instructions and guidance, enhancing interactions, and offering flexible options. For the accessibility of support, OAs desire immediate support. While this type of instant response is difficult to achieve in reality. Secondly, providing intuitive instructions and guidance is needed. OAs expect the system to provide guidance that is easy to understand and follow, with steps and instructions clearly transformed into operations and highlighted on the interface, e.g., red square. Moreover, enhancing interactions. OAs expect a more interactive experience, including real-time feedback (e.g., "*Let me know if I clicked the right button.*") and Q&A (e.g., "*It can respond immediately when I have a question.*"). Besides, offering flexible options. For configuration-related tasks, OAs prefer to complete tasks with minimal effort. For operation-related problems, they hope to receive detailed instructions.

Expectations of YFMs. Similar to OAs, YFMs' expectations are grounded in the challenges they encounter during the support process, but they also reflect some other needs, including reducing time and efforts, providing feedback, and maintaining participation and connection. Firstly, YFMs prioritize efficiency in the support process, expecting that their time on solving a problem can be reduced. The second is providing feedback. YFMs expect to track OAs' progress on learning configuration-related tasks, like "*I want to know whether the problem has been solved.*" This helps YFMs ensure that OAs get the correct outcomes. For maintaining participation and connection, YFMs hope themselves to be involved into the support process. YFMs perceive this procedure as not only problem-solving but also opportunities to strengthen the emotional connection.

Expectation Gaps between OAs and YFMs. There are several gaps of expectations between OAs and YFMs, which gives chatbots scenarios to play roles.

- **Conflict in Granularity: Detailed Guidance vs. Quick Resolution.** OAs and YFMs exhibit different preferences in the guidance level. OAs typically favor detailed guidance and step-by-step explanations, aiming not just to solve the problems but to gain a deeper understanding. Many OA participants shared similar experiences, with OA7 saying, "*He just told me where to click, but I didn't understand the underlying logic.*" In contrast, YFMs expect to solve the problems efficiently and quickly. They often prefer to simplify the support process to direct steps, avoiding lengthy explanations. YA5 mentioned, "*I just tell her where to click, and that's it. I don't want to spend too much time explaining.*"
- **Temporal and Spatial Conflicts: Immediate Needs vs. Belated Support.** OAs generally expect immediate support when they encounter issues. They hope get prompt guidance like "*request and respond*" (OA11). However, some OAs like OA7 have become hesitant to seek help from their children due to unsuccessful experience: "*When I used to ask him for help, I often had to wait until he finished work... I try not to bother him anymore.*" On the other hand, due to daily working and studying, YFMs struggle to respond to OAs' needs immediately, resulting in a mismatch between OAs' needs and YFMs' support.
- **Misalignment between Guiding and Following: Complex Instructions vs. Weak Comprehension.** Another conflict is the misalignment between YFMs' instructions and OAs' understanding and following. YFMs often expect OAs to execute instructions accurately.However, due to OAs' difficulties in understanding ICT concepts and conducting operations, their executions deviate from the expected. For example, YA7 shared, "*I told her to find the 'three-dot menu', but she kept clicking on the settings, confused by similar-looking icons with three dots.*" Furthermore, OAs' struggle with technical terms, further exacerbates this misalignment. OA5 described, "*He's teaching at a high school level, but I understand at an elementary level.*" OAs expect each action to yield clear and visible feedback, while YFMs tend to rely on concise and directive instructions. This gap leads to discrepancies between understanding and execution.

3.3 Design Strategies

Based on the above expectations of OAs and YFMs, especially the expectation gaps, we propose the following strategies to guide the design of systems to enhance OAs and YFMs' experiences in addressing smartphone usage problems.

- **DS1**: Enhancing support for OAs while reducing the workload of YFMs. In the design of a system to facilitate YFM-supported smartphone usage problem-solving for OAs, both OAs and YFMs perspectives should be considered. The crucial design consideration is how to bridge the gaps between these two groups of stakeholders, ensuring that OAs can obtain overall high-quality support while YFMs do not need to cope with high workload.
- **DS2**: Enhancing OAs' experience through flexible guidance and feedback. From the perspective of OAs, the system should be characterized with: (1) flexible guiding modes such as *step-by-step* and *one-click-go* proxy actions (F1); (2) real-time feedback indicating the correctness of each operation (F2, F3); and (3) explanations of ICT terms and UI elements (F2).

- **DS3**: Expanding YFMs' problem-solving capabilities but reducing workload. From the perspective of YFMs, the system should be characterized with: (1) multiple solution-finding methods tailored to different knowledge levels, such as letting the system to find solutions when YFMs do not know OAs' problems very well (F2); (2) supporting solution reusing to cope with OAs' repeated asks about the same problem (F2, F3); and (3) a feedback mechanism allowing YFMs to know OA's progress in problem solving (F3).
- **DS4**: Maintaining Participation of OAs and YFMs. The aim of the system is not to replace OAs or YFMs but to assist them. For example, the system does not replace OAs to directly complete tasks but instead guides them to take operations step-by-step; and the system should inform YFMs about OA's progress in problem solving to ensure YFMs' timely perception and control.

4 WePilot

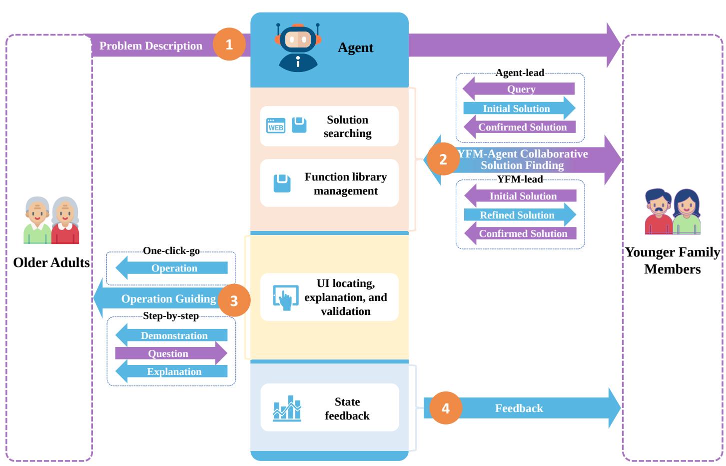

Fig. 2. System architecture overview, where orange numbers indicate the interaction process between OAs/YFMs and the system, blue arrows represent WePilot-processed information, and purple arrows indicate user-initiated interactions.

The above four design strategies, especially the expectation gaps between OAs and YFMs, motivates us to build a chatbot-mediated system WePilot to assist OAs and YFMs to collaboratively solving smartphone usage problems. As mentioned above, chatbots are more accessible, flexible, and knowledgeable, showing great potential to mediate OAs and YFMs' gaps in supporting time, guidance granularity, and knowledge level. As shown in Figure 2, WePilot serves as an intelligent mediator, facilitating the engagement of OAs in the support process in an intuitive, interactive, and cognitively lightweight manner, while also allowing YFMs to engage flexibly with minimal cognitive and time demands. WePilot is structured into three components corresponding to the overall support workflow: 1) Solution Finding Module: collaborates with YFMs through two flexible approaches to determine solutions and manages a Function Library; 2) Operation Guiding Module: provides OAs with two forms of operation guidance to accommodate different problem types; 3) Feedback Module: Tracks OAs' progress in problem-solving and presents it to YFMs.

4.1 Solution Finding Module

Based on the design strategies DS1 and DS3 from our Formative Study, we developed two distinct Solution Finding modes (Figure 2-2). These modes are designed to accommodate different scenarios, i.e., YFMs know the solution well or do not.

4.1.1 YFMs know the solution well. The *YFM-lead* mode is designed primarily for situations where YFMs possess knowledge of the solution. Based on our Formative Study, YFMs in traditional support contexts need to consider their own availability and OAs' ability to understand online tutorials. WePilot simplifies this process by converting brief descriptions or online tutorial resources into structured solutions (DS3). In this mode, YFMs can provide initial solutions via: 1) natural language descriptions when time permits or suitable online tutorials are unavailable (Figure 3(a)), or 2) direct tutorial links when time-constrained but online resources exist (Figure 3(b)). Either method is followed by a refine-confirm process, after which the confirmed solutions are stored in the Function Library (Section 4.1.3) for OAs to access (Section 4.2).

The *YFM-lead* mode maintains YFMs' awareness and control over the solution (DS4) while reducing cognitive load (DS1). Although primary interactions are simplified, YFMs retain the option to provide detailed guidance, including step-by-step instructions, explanations, and recommendations, all of which WePilot preserves for OAs' reference.

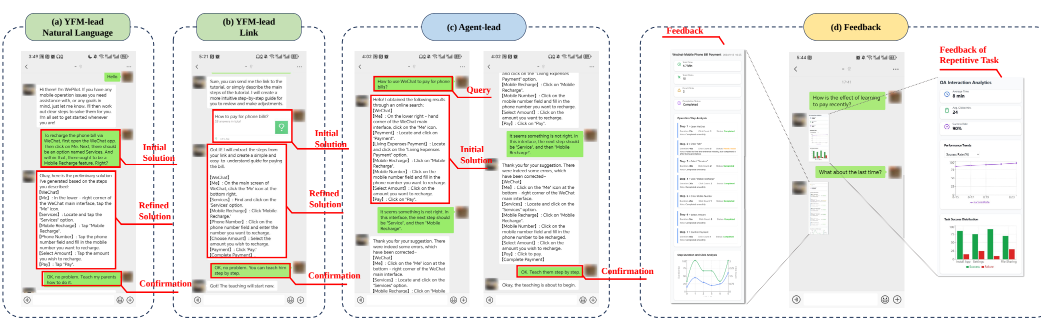

Fig. 3. Interaction interface between YFMs and WePilot, displaying three modes of solution provision and state feedback.

4.1.2 YFMs do not know the solution well. The *Agent-lead* mode is designed primarily for situations where YFMs encounter problems beyond their knowledge scope. As identified in our Formative Study, YFMs traditionally give up providing support when they lack solution knowledge, leading to missed support opportunities. WePilot streamlines this process by expanding YFMs' knowledge and automating solution discovery, enabling them to make informed decisions and provide support with knowledge enhancement (DS1, DS3). In this *Agent-lead* mode, YFMs can formulate queries based on their understanding of OAs' issues. WePilot then uses these queries to generate initial solutions by leveraging web search results with Function Library queries. YFMs can subsequently review these initial solutions, verify their accuracy, assess their safety, and make any necessary adjustments to create a confirmed solution, which is then used to support OAs (Figure 3(c)).

It is important to clarify that our goal is to alleviate the discomfort YFMs may feel when unable to address OAs' issues and reduce their reluctance to provide support in unfamiliar areas, rather than compelling YFMs to offer support. YFMs retain control over the solutions and the decisions to provide support. They also can opt not to provide support if they deem the feature risky for OAs (DS4).

4.1.3 Function Library and Reuse Mechanism. Reducing time cost for YFMs, as outlined in our Formative Study's Design Strategy (DS3), is a crucial approach to mitigating time conflicts between OAs and YFMs (C2). WePilot implements this through the *Agent-lead* mode in the Solution Finding phase, minimizing YFMs' need to search independently and preventing repeated inquiries from OAs on the same issues. To achieve this, we developed the Function Library and a reuse mechanism.

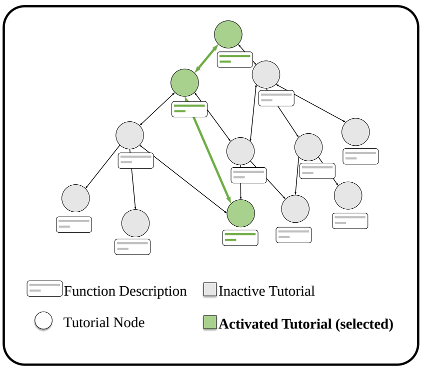

Fig. 4. Function Library Structure Diagram. Nodes represent smartphone interfaces and edges indicate navigation paths between interfaces.

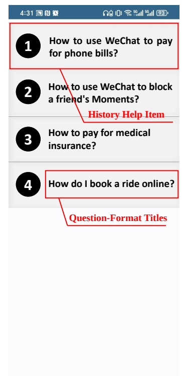

Fig. 5. History Help Panel.

The Function Library is structured as a graph (Figure 4). It stores confirmed solutions as internalized data and enables retrieval of these solutions in the *Agent-lead* mode to generate appropriate operation pathways. As support interactions between YFMs and OAs accumulate, the Function Library expands, enabling WePilot to provide increasingly appropriate suggestions. Since the Function Library is composed of previously operational pathways, YFMs can spend less time reviewing and confirming each solution.

The reuse mechanism is designed as a panel containing multiple historical support interaction records (Figure 5). It logs support instances and displays them as question-format titles, making it easier for OAs to locate relevant solutions. OAs can choose to revisit solutions previously provided by YFMs, sparing YFMs from repeated instructions for the same problems. Notably, since the support provided has been verified and confirmed by YFMs, they can be considered to participate asynchronously in supporting with repeated questions. This aligns with our emphasis on YFMs' control over the support process (DS4).

4.2 Operation Guiding Module

WePilot provides OAs with an intuitive and cognitively lightweight format for receiving support. As shown in Figure 2-3 and line with DS2, we designed this module to offer OAs two forms of operation guidance: ***step-by-step*** guidance and ***one-click-go*** operation. Through this module, we attempt to mitigate OAs and YFMs' conflict between detailed guidance and quick resolution (C1), as well as the knowledge gap (C3).

4.2.1 Step-by-step Mode. For issues identified by YFMs as Operation-type, our Formative Study established two core objectives in this mode: to provide intuitive guidance enabling OAs to follow step-by-step operations (DS1), and to offer immediate feedback to confirm or correct OAs' clicking behaviors, ensuring they feel confident in the accuracy of each interaction (DS2). Figure 6

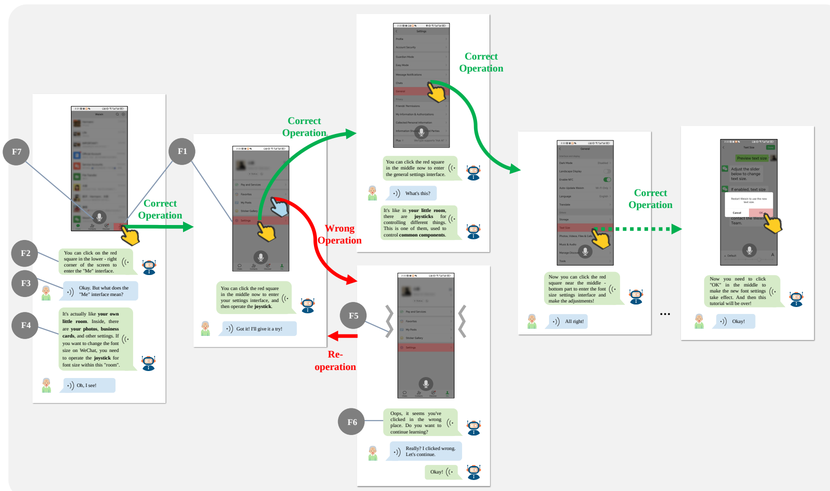

Fig. 6. Interaction process between OAs and WePilot. Green arrows indicate the correct operation paths, while red arrows show incorrect operations and subsequent recovery steps.

demonstrates the step-by-step interaction flow between OAs and WePilot. In this mode, OAs follow visual highlights (F1) and voice prompts (F2) to interact with marked UI elements. When a correct action is taken, the interface updates accordingly, providing visual and audio feedback to confirm accuracy. If an incorrect action occurs, WePilot immediately provides feedback through vibration (F5) and a voice notification (F6).

OAs can press and hold the voice button (F7) to ask questions about interface elements, ICT terms, or operational steps (F3). WePilot generates comprehensible explanations (F4) based on the current operations and context, specifically designed for users with low digital literacy. The system uses metaphors to translate technical concepts, converting abstract ICT terms (e.g., cache, background running) into familiar analogies (e.g., “temporary drafts,” “TV running while doing other things”). These features fulfill our design goals of providing intuitive, cognitively lightweight instruction (DS2). Additionally, since OAs control each interaction, they can choose to stop at any time, maintaining control over their learning process (DS4).

4.2.2 One-click-go Mode. Beyond operation-type issues, we designed the flexible guiding modes such as *step-by-step* and *one-click-go* mode to address configuration-type issues. Given the low frequency and typically one-time nature of these tasks, the goal of this mode is not to teach OAs or ensure they remember the steps, but rather to be solution-oriented (DS2). In the *one-click-go* mode, the interface OAs interact with remains largely the same as in the step-by-step mode. However, OAs do not need to execute most actions themselves; the system performs these actions automatically, except for privacy-related steps, which require OAs’ input. This mode aligns well with OAs’ expectations for simplified, automated operations.

Although this mode minimizes the need for OAs to perform actions, OAs still retain control over the process (DS4). WePilot displays the elements it intends to select, allowing OAs to see each action beforehand. If OAs prefer, they can also choose to perform the highlighted actions themselves after WePilot indicates the relevant elements.

4.3 Feedback Module

Providing feedback mechanisms to YFMs based on OA's guided interactions with WePilot(Figure 2-4) is a crucial design element for ensuring control (DS4). As shown in Figure 3(d), YFMs can access interaction records with OAs through WePilot at any time, including quantitative metrics such as task completion time, click accuracy, and the number of attempts required. These data points are presented through intuitive visualizations, enabling YFMs to quickly identify OAs' interaction patterns and potential difficulties. For repetitive tasks, the system tracks and displays changes in these metrics over time, allowing YFMs to monitor OAs' progress.

This feedback mechanism enhances YFMs' engagement in the support process while maintaining their autonomy (DS4). By providing clear visibility into OAs' interaction patterns, WePilot enables YFMs to make informed decisions on when and how to offer additional support.

4.4 Example Process

In this section, we demonstrate a specific case illustrating how OAs and YFMs use WePilot for remote smartphone technical support.

An OA encounters difficulties with overwhelming irrelevant posts from an unfamiliar user on their social media feed. OA first searches the support history provided by WePilot but finds no prior support from YFM on this issue. OA then sends a help request to YFM, describing the problem. Upon receiving OA's request, YFM, based on personal experience, identifies that OA wishes to mute the user's posts. Although YFM is familiar with the process, time constraints lead her/him to provide a brief description of the muting steps to WePilot. It then generates and presents a refined, step-by-step solution for YFM's review and confirmation. After the confirmation, the solution is recorded and sent to OA. Following YFM's confirmation, WePilot initiates step-by-step guidance mode. The system highlights key UI elements on OA's screen and provides audio prompts to guide them through the process. During the process, OA poses questions about the difference between "unfollow" and "unfriend" to WePilot. WePilot uses the metaphor of "muting a TV channel" and "canceling the TV subscription" to clearly explain the difference between them. When OA attempts to click a small icon in the upper right corner, he makes an incorrect click accidentally. But with a reminder from WePilot, she/he quickly realizes the mistake and returns to the correct action path. Finally, when OA successfully mutes the user's posts, WePilot compiles the operation details (objective metrics) into a summary chart for YFM. Upon review, YFM sees that OA has completed the process smoothly and solved his problem effectively.

4.5 Implementation

4.5.1 Android Application. In this study, we developed and tested the functionality of the WePilot application on standard Android devices. For the OAs side, the application was built using Kotlin, requiring only accessibility service permissions and no root access. WePilot operates as a background application. Additionally, following the approach outlined in [102], we implemented the method shown in Figure 6 to optimize the highlighting of UI elements, enhancing both visual clarity and usability. For YFMs, WePilot was implemented as a Chatbot within the WeChat platform. The selection of WeChat as the platform was based on several considerations: first, WeChat has a large user base in our study region, with widespread adoption among both older adults and younger family members. Second, WeChat's instant messaging capabilities enable YFMs to respond immediately to OAs' requests and interact with WePilot in real time, increasing the efficiency of support. Furthermore, WeChat supports multiple interaction modes, including text and images, providing WePilot with rich interaction methods to meet diverse user needs. Through this design, we aim to enhance communication between OAs and YFMs, improving the effectiveness of support and user experience.

4.5.2 Backend Components. WePilot's backend components are primarily developed in native Python and deployed on a development server using the Flask framework. The system's sentence generation module utilizes OpenAI's GPT-4o model[1], chosen for its superior performance in response speed and processing efficiency compared to other closed-source models, particularly excelling in multi-turn conversations. For the MLLM component, we selected the gpt-4-vision-preview model[2], which builds upon [100], and includes additional text extraction capabilities. This integration combines XML tree and screen capture information to enhance the accuracy of UI element recognition. The Function Library module employs the highly-ranked bge-large-zh-v1.5 model from MTEB[3] and the FAISS library to optimize functionality recall efficiency and accuracy.

4.5.3 TTS & STT. We adopted the iFLYTEK's[4] speech recognition SDK to enhance recognition accuracy for older users' speech, as this SDK demonstrates significant advantages in recognizing both Mandarin and common dialects. To accommodate the unique speech patterns of older adults [88, 108], we adjusted the recognition interval and maximum recognition duration to 9 seconds and 60 seconds respectively. For text-to-speech (TTS) conversion, we utilized Android's native TTS interface to ensure system stability and compatibility.

5 Evaluation

We conducted an evaluation to evaluate WePilot system. This evaluation explored the following evaluation questions:

- Q1: How do YFMs and OAs use WePilot?
- Q2: Can WePilot alleviate the burden of remote technical support for both YFMs and OAs?
- Q3: Do YFMs and OAs find WePilot usable, effective, and satisfactory?

5.1 Evaluation Details

5.1.1 Procedure. In this evaluation, we recruited 12 pairs of participants (P1-P12) through local community centers. Each pair consisted of one YFM aged 22-32 and one OA aged 66-80. All participants had experience providing/seeking help with smartphone usage issues in the past month. Their detailed information is displayed in Table 3.

All sessions were conducted in community activity room and took approximately 90 minutes. At the start of the session, participants were required to sign informed consent and completed demographic questionnaires. Then each pair was asked to complete six APP-related tasks jointly with our experimental devices, by providing/processing help with or without assistance of WePilot. To better simulate real-life scenarios in the experiment, we: (1) contextualized the 35 features within realistic daily scenarios rather than presenting them directly. OAs selected six scenarios of greatest interest to them and learned to use them by using different support method until self-reported task completion; (2) physically separated YFMs and OAs during the experiment to prevent interference. To mitigate potential cognitive overload from completing six tasks, we improved the design of our experiment from the following two aspects: 1) OAs could flexibly select six scenarios based on personal interest, which can ensure task engagement aligned with their preferences, thereby reducing cognitive load caused by task assignment [58]; 2) Participants were allowed to pause and

[1]https://platform.openai.com/docs/models/gpt-4o
[2]https://openai.com/index/gpt-4v-system-card/
[3]https://huggingface.co/spaces/mteb/leaderboard
[4]https://www.xfyun.cn/

Table 3. Demographic information of OA and YFM pairs in Evaluation. "F" represents "Female", and "M" represents "Male".

Pair ID	OA Age & Gender	YFM Age & Gender	Intergenerational Relations	Frequency of Requested Help
1	70, F	30, F	Parent-Child	3-5/month
2	68, M	32, M	Parent-Child	3-5/month
3	74, F	26, M	Parent-Child	<3/month
4	72, M	25, F	Parent-Child	6-8/month
5	66, F	22, F	Grandparent-Grandchild	3-5/month
6	80, M	24, M	Grandparent-Grandchild	<3/month
7	75, F	28, M	Grandparent-Grandchild	3-5/month
8	78, M	23, F	Grandparent-Grandchild	6-8/month
9	69, F	31, F	Parent-Child	3-5/month
10	67, M	29, F	Parent-Child	<3/month
11	73, F	27, M	Grandparent-Grandchild	6-8/month
12	71, M	30, F	Parent-Child	3-5/month

quit the experiment at any time, avoiding potential cognitive fatigue. Before the experiment, we explicitly explained these instructions to the participants. During experiments, we observed that no participant chose to pause or quit, suggesting no apparent cognitive load.

In each experiment, we firstly demonstrated the usage of WePilot for YFMs and OAs separately. Then participants completed three APP-related tasks with each support method, phone call and WePilot. The reason to choose phone call as the baseline is the most common method for YFMs and OAs to provide/seek remote technical help. In each task, OAs were asked to select one feature from 35 WeChat features options (identified as commonly used but not fully mastered by OA through formative study), then seek help from YFM to use this feature. These features were categorized according to complexity levels based on criteria proposed by [17]. When using WePilot, OAs had the permission to select the guiding modes (*step-by-step* and *one-click-go*).

After the experiment, we designed a two-stage evaluation framework to comprehensively assess WePilot's performance: intrinsic performance evaluation and user evaluation. In the former stage, we focused on investigating the quality of the content generated by WePilot, as shown in Table 4. For the subjective metrics (the accuracy of explanation and the reasonability of explanation), two authors independently rated the results, and then we evaluated the consistency and utilized the mean value for evaluation to enhance the reliability. For user evaluation, participants responded to a set of Technology Acceptance Model (TAM) questionnaires [38, 107], then we conducted 20-minute semi-structured interviews with each pair of participants to gather qualitative feedback on their experiences with WePilot. All interviews were recorded and transcribed after the participant's informed consent. At the end of the interview, participants were compensated with $15 for their time.

5.1.2 Data Analysis. We employed both qualitative and quantitative methods to delve into the evaluation questions. For Q1, Q2, and Q3, qualitative methods were adopted to analyze semi-structured interviews and audio recordings from experimental sessions. The coding method for the transcript data followed a procedure similar to that described in Section 3.1.2. For Q2 and Q3, we also employed quantitative methods to analyze the interaction logs and TAM scales. For interaction logs, we automatically extracted the timestamps from system logs and computed time efficiency

Table 4. The framework for intrinsic performance evaluation.

Dimension	Sub-dimension	Metric	Measurement
WePilot's generated content for OA	Operation	Accuracy	The proportion of highlighted UI elements that matched the correct ones.
	Explanation	Accuracy	The mean value of accuracy of explanation. Each explanation's accuracy is rated on a 5-point Likert scale (1=Poor, 5=Excellent).
		Reasonability	The mean value of reasonability of explanation. Each explanation's reasonability (metaphors and other expressions used for explanation) is rated on a 5-point Likert scale (1=Poor, 5=Excellent).
WePilot's generated content for YFM	Solution	Reliability	The proportion of solutions that all steps align with the optimal operation path.

for WePilot, while the baseline's (phone call) time efficiency was evaluated by manually analyzing screen recordings. Paired t-test was then used to validate the efficiency difference between WePilot and baseline. In terms of TAM scales, given the small participant size and non-normal distribution of a dimension's responses, we performed Wilcoxon signed-rank test to assess the difference between WePilot and baseline. Cohen's d was also calculated to validate effect size.

5.2 Evaluation Results

5.2.1 Q1: How do YFMs and OAs use WePilot?

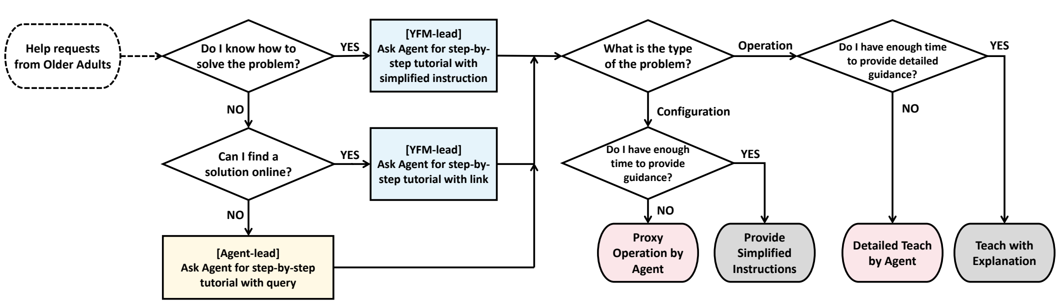

Fig. 7. Updated decision flowchart for YFMs processing smartphone help requests from OAs assisted by WePilot.

During the entire experiment, all of our participant pairs completed a total of 36 trajectories consisting of 385 operations. From the perspective of content generated for OA, the operation accuracy reached 93.8% (361/385) during the experiment. For both explanation accuracy and reasonability, the ratings from two independent authors showed a high level of agreement (Cohen's kappa > 0.8). The average explanation accuracy reached 4.9 out of 5, which shows the richness of internal knowledge in MLLMs and their potential to help older adults understand technical terms. The average reasonability score was 4.06 out of 5, and 82.5% of the ratings were good (4) or excellent (5), suggesting the explanations were mostly reasonable. After analyzing the system errors, we found that operation-level mistakes mainly resulted from MLLMs' limitation in locating complex UI elements, especially icon-based controls without text labels (e.g., the hamburger menu "≡" and the vertical ellipsis "⋮"). Additionally, we found that in different sessions, the system's metaphorical explanations for the same concept (e.g., "cloud storage") were sometimes inappropriate (e.g., "a virtual hard drive on the internet") or inconsistent (e.g., "a safe deposit box"). With the advancement of pre-training and reinforcement learning techniques, LLMs' capability of multimodal comprehension increases continually [83, 89, 104], which provides the potential for alleviating these operation-level problems in the future.

From the perspective of the content generated for YFMs, the initial solutions in the Agent-lead mode were 100% accurate (25/25), while the final solutions in the YFM-lead mode achieved 90.9% accuracy (10/11). We thought this high accuracy primarily stems from the Function Library, which improves solution formation by organizing operation pathways into directed graphs. In total, 91.7% (33/36) of trajectories were successfully completed. For the unsuccessful cases, we found the failures mainly originated from users' mistakes, i.e., YFMs provided incorrect solutions (1/3) or OAs made erroneous clicks (2/3).

Above all, we can see that WePilot's intrinsic performance (operation accuracy, solution reliability, etc.) is overall acceptable, laying the foundation for user evaluation.

To understand the decision model of remote technical support between OAs and YFMs with assistance of WePilot, we analyzed participants' behaviors observed during experiment and their statements from interviews. The results are illustrated as follows and shown in Figure 7.

- **Problem Initiation Phase.** While most OAs prefer to directly express their need for help to YFMs, 2 of OAs attempted to interact with WePilot. The latter expressed a preference for self-reliance, stating they "*didn't want to ask [their children]*" (P6-OA) and believed that "*it's better to solve problems independently*" (P2-OA, P7-OA). They were attracted to WePilot's "*neutral*" (P1-OA) nature and its "*polite and patient*" (P9-OA) characteristics.
- **Solution Acquisition.** Overall, 9 of YFMs showed a preference for *Agent-lead* mode, they often relay OAs' questions directly to WePilot, reducing the process of discussing the problem with the OAs. Specifically, four YFMs who encountered unsolvable problems selected the *Agent-lead* mode. Surprisingly, five out of the remaining eight YFMs continued using *Agent-lead* mode even when they knew the solution. They explaining that "*[Agent-lead] is much more convenient than explaining it myself (YFM-lead).*" (P4-YFM).
- **Support Decision Making.** Regarding time investment, only 3 of YFMs considered their availability as a factor in deciding whether to provide support personally. As P10-YFM noted, "*I would definitely use this when I'm busy, but I prefer explaining personally when I have time.*" Survey results indicated a significant increase in YFMs' willingness to provide support under time constraints (from Mean = 2.92 to Mean = 3.75, $p < 0.01$). P2-YFM noted, "*Previously, I might have avoided helping due to time concerns, but now with WePilot, it takes just a few minutes, I feels much easier.*"
- **Solution Presentation Negotiation.** YFMs and OAs actively negotiated between "learning" and "solving" objectives. For instance, P3-OA preferred alternative operations, "*It's great that it helps me click through without having to think,*" while P3-YFM "*would rather they learn it themselves instead of relying on [WePilot] every time.*" This divergence encouraged communication, "*I first ask if they want to learn before deciding which method to use.*" (P5-YFM). Furthermore, we noted P4-OA's concern about the reduced intergenerational interaction, "*Although the system is helpful, I miss the detailed explanations my daughter used to give. WePilot is efficient, but sometimes I feel we're losing those teaching moments we used to have.*"

- **Post-Support Interaction.** 6 of participants engaged in extended discussions after problem resolution. For example, after adjusting WeChat font size, P1-OA discussed eye health with their children, "*My eyes get very tired when using the phone; I didn't know I could adjust it like this.*" Similarly, after learning to set message notifications, P4-OA shared his frustration about "*missing your calls because I couldn't hear the phone*," leading to YFM suggesting setting personalized ringtones for specific contacts. Another type of interaction focused on solution process feedback. As P7-YFM described, "*Mom tells me whether she understood using WePilot and which parts weren't clear*," such feedback helped YFMs better understand OAs' learning experiences.

Overall, the introduction of WePilot transformed the remote technical support model from traditional direct support model to an agent-mediated support model. This new model exhibits three key characteristics: (1) YFMs' support decisions become more flexible, with time no longer being the primary consideration; (2) OAs demonstrate increased initiative in seeking help with smartphone usage; (3) interaction forms become more diverse, expanding from pure technical guidance to solution presentation negotiation and extended discussions. The paradigm shift in intergenerational technical support and its implications will be discussed in detail in Section 6.1.

5.2.2 Q2: Can WePilot alleviate the burden of remote technical support for both YFMs and OAs? We evaluated our system effectiveness in reducing the burden for both YFMs and OAs from both subjective and objective dimensions. The subjective dimension is measured through questionnaires and interviews, for assessing perceived mental effort reported by YFMs as well as perceived cognitive and psychological burden reported by OAs. The objective dimension is measured by calculating time cost metrics, which is used to reflect the efficiency. For task τ_i, the time cost (s[5]) of YFM or OA is defined as C_i^{YFM} or C_i^{OA} respectively:

$$C_i^{\text{YFM}} = \frac{(t_{end,i} - t_{r,i}) + (t_{conf,i} - t_{comp,i})}{S_i},$$
$$C_i^{\text{OA}} = \frac{t_{comp,i} - t_{r,i}}{S_i},$$

where S_i indicates the minimum number of steps required to complete the task (the complete process from OAs' initial question to YFMs' confirmation of problem resolution), $t_{r,i}$ indicates the time when OA initiates the request, $t_{end,i}$ indicates the time when YFM ends explicit interaction, $t_{comp,i}$ indicates the time when OA completes the task, and $t_{conf,i}$ indicates the time when YFM confirms task completion.

Regarding objective measurement, Figure 8 shows the time cost comparison of YFMs and OAs under different support methods (baseline and WePilot). For YFMs, the average time cost decrease approximately 42% after use WePilot, from 34.34 (SD = 10.87) with baseline method to 20.00 (SD = 6.57) with WePilot. Paired t-test on time cost also revealed that WePilot significantly improved YFMs' efficiency ($t = 7.73$, $p < 0.001$, Cohen's $d = 1.82$). Additionally, the decrease in interquartile range (from 16.16 to 5.46) indicates that support processes with WePilot have less efficiency variation and are more stable. For OAs, although the efficiency with assistance of WePilot is not significantly improved compared with baseline at the 0.05 significance level (time cost decrease from 34.34 to 28.54, $p > 0.05$), it shows that time cost is more stable (SD decrease from 10.87 to 6.76). This improvement indicates that WePilot provides a more consistent learning experience across different tasks. Moreover, the influence of WePilot on interaction patterns is particularly significant. Traditional remote support shows a perfect correlation between YFMs and OAs time cost metrics ($r = 1.00$, $p < 0.001$), reflecting synchronous interaction where both parties needed to communicate in

[5] s indicates second

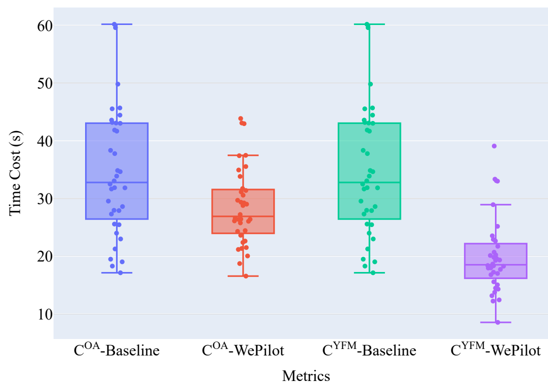

Fig. 8. Efficiency comparison of YFMs and OAs under different methods.

real-time. However, the introduction of WePilot significantly reduced this correlation ($|r| = 0.22$, $p = 0.20$). This decrease suggests a degree of decoupling between YFMs' support provision and OAs' support reception, enabling asynchronous support.

Regarding subjective report, YFMs indicated that they had lower mental effort when using WePilot (from Mean = 3.50 to Mean = 4.33, $p < 0.05$). Specifically, 10 of YFMs mentioned that WePilot's proactive solution provision helped reduce mental effort. As P3-YFM noted, "*Having ready-made solutions eliminates the need to devise explanations*," while P7-YFM emphasized, "*I just need to verify and approve, it's very simple*." For OAs, they indicated that: (1) The multimodal guidance is easier to follow (Mean = 4.75), as P2-OA noted that, "*With this tool, you think less... it highlights where to click in red, making it immediately clear*," almost all participants expressed the similar feelings. This aligned with our observations of improved efficiency from objective quantitative measurement; (2) They perceived lower psychological pressure (Mean = 3.92), with 10 of OAs reporting reduced stress. As P8-OA noted that, "*I can take my time without worrying about taking up too much of my children's time*." This reduction in stress may stem from the asynchronous interaction pattern ($r = 0.21$).

However, we also received some negative feedback. For example, outliers of C^{YFM}-WePilot shown by the purple bar in Figure 8 (range from 32 to 40). By reviewing interview records and examining the data, we found that these may be caused by incorrect initial solutions provided by YFMs (1/3) and inaccurate UI element localization performed by OAs (2/3). The former required YFMs to carefully verify and re-provide support, while the latter indicated trying again. Nevertheless, even with these cases, WePilot maintained efficiency comparable to baseline. Regarding C^{OA}-WePilot outliers shown by the red bar in Figure 8 (range from 42 to 45), we found these occurred when OAs had doubts about WePilot's instructions, leading to increased dialogue rounds and completion time.

Overall, WePilot demonstrates prominent effectiveness in reducing remote technical support burden for both YFMs and OAs. It decouples the support process, reducing YFMs' mental effort to provide support while providing OAs with intuitive and low-pressure processing support experiences. Despite technical challenges in UI element localization and explanation provision, WePilot maintained efficiency levels comparable to baseline.

5.2.3 Q3: Do YFMs and OAs perceive WePilot as usable, effective, and satisfactory?

To explore OAs' and YFMs' perceptions of WePilot's usability, effectiveness, and satisfaction, participants completed the TAM scale [38, 107] after experimenting with each method (baseline and WePilot). This scale is designed items based on seven core dimensions, including perceived usefulness, perceived ease of use, attitude, behavioral intention, self-efficacy, technology anxiety, and social support. For example, for perceived usefulness, items include "*This method enables me to solve smartphone use issues more effectively*."And for perceived ease of use, items include "*Using this method to solve smartphone use issues is very easy for me*." Additionally, we gathered qualitative feedback through semi-structured interviews. The results of the Wilcoxon signed-rank test indicate that OAs' overall acceptance of the WePilot is significantly higher than that of traditional remote support methods (Median = 35.0 vs. 28.0, $p < 0.01$), demonstrating that WePilot is acceptable overall. Notably, WePilot received significant improvements on six dimensions, with $p < 0.01$ on perceived usefulness and attitude and $p < 0.05$ on perceived ease of use, behavioral intention, self-efficacy, and technology anxiety.

From the perspective of OAs, participants expressed high satisfaction with WePilot's OA-oriented features (Mean = 4.42, SD = 0.64), with 11 of OAs showing preference for *step-by-step* guiding mode. Specifically, visual highlighting and voice prompts (12/12), concept explanation generation (10/12), and *one-click-go* mode functionality (10/12) emerged as the most popular features. As P1-OA explained, "*With this (visual highlighting and voice prompts), I can immediately identify where to click, unlike before when I struggled to locate things despite lengthy explanations from my children*." However, we observed that OAs with higher digital literacy showed varying needs for certain features, particularly regarding concept explanations. P6-OA, a middle school teacher, felt "*underestimated*" by WePilot's concept explanations. Additionally, P9-OA also identified inconsistencies in concept explanations, she noted that, "*It was described as a drawer last time but as a menu this time, which confused me*." For YFMs, they particularly valued WePilot's support history reuse (12/12) and *Agent-lead* mode (9/12). They generally regard WePilot as "easy to use," "time-saving" and "labor-saving." As P3-YFM stated, "*Now I don't need to repeatedly explain the same issues, ... which saves significant time*." However, some YFMs expressed security concerns, with P7-YFM noting, "*I worry about potential hacking or theft compromising my parents' phones*." The most controversial design was the choice between *one-click-go* mode and *step-by-step* mode for OAs. While 8 of OAs explicitly preferred the *one-click-go* mode, "*I prefer direct completion over step-by-step learning with doing nothing. It's very convenient.*" (P2-OA), over 9 of YFMs expressed concerns about this mode potentially "*affecting learning effectiveness*" (7/12), leading to "*being controlled*" (7/12), and "*complete tool dependency*" (5/12).

Overall, despite specific feature controversies (to be discussed in detail in Section 6.2), both YFMs and OAs found WePilot to be a usable, effective, and satisfactory system. The system's advantages in improving learning efficiency and reducing communication costs received widespread recognition from both parties.

6 Discussion

The evaluation results revealed WePilot's several superiorities in addressing the expectations of OAs and YFMs, while some features still need further improvements. We summarize WePilot's strengths and weaknesses in Table 5 in Appendix B. Based on that, the following sections will discuss the pros and cons of introducing chatbot into intergenerational technical support and the implications for designing remote intergenerational technical support tools.

6.1 Balancing Chatbot and Intergenerational Interaction in Intergenerational Technical Support

Previous research has primarily focused on supporting OAs independently learning or accessing social support when facing smartphone usage issues. Through our formative study, we found that YFMs, which serve as important social support sources for OAs, often have challenges to teach OAs' smartphone usage, resulting in several gaps between OAs' expected support and YFMs' guidance. Based on these findings, we introduced chatbot into the support procedure to mediate the gaps and built WePilot, a system to integrating YFMs and chatbot to support OAs' smartphone usage, aiming to improve the effectiveness and efficiency of OAs' learning and reducing YFMs' efforts. WePilot transforms the traditional remote technical support mode by changing the synchronous participation requirement, enabling a more flexible support mode of asynchronous engagement. Our experimental evaluation demonstrated WePilot's advantages in reducing burden for both parties by taking advantage of chatbot's autonomy and intelligence, increasing YFMs' willingness to support and OAs' learning experience. However, the introduction of chatbot also brings some drawbacks and even risks into intergenerational interactions. This section discusses these innovative findings to shed light on the future research of asynchronous intergenerational technical support tools.

6.1.1 Strengths.

- **Enhanced Flexibility**: The shift to asynchronous participation has transformed the temporal requirement for social support from *mutual presence* to *individual independence* [22]. It promotes flexibility for both parties. Specifically, the asynchronous nature creates a "distributed learning space"[42, 85, 94], wherein YFMs "*no longer need to wait for OAs' operations*" after providing solutions, and OAs can also "*proceed at their own pace,*" gaining more flexibility to control over their supporting and learning process. This design helps avoid the mismatch between YFMs' teaching and OAs' learning pace [75], improving efficiency and also reducing the occur of conflicts.
- **Increased Willingness to Seek and Provide Help**: After introducing chatbot into the loop, the relationship between YFMs and OAs shows a tendency to evolve from *request and response* (OAs ask for help, and the YFMs respond) to *proactive support* (YFMs actively give helps)[86]. Under the traditional mode, limitations in time, efforts, and knowledge often lead YFMs to give up supporting. With WePilot's assistance, YFMs demonstrated significantly increased willingness to provide support (Section 5.2.1). Such enhanced willingness indicates that YFMs have shifted from viewing technical support as a "burden" to perceiving it as a relaxed and enjoyable "casual activity." In other words, the formality and completeness requirements of technical support process have been dissolved [68], reducing YFMs' workload and stress. Consequently, OAs show greater willingness to seek and accept help [81], and YFMs demonstrate increased motivation to provide help [81].
- **Strengthened Negotiation**: With our system, the supporting process begins to shift from *unidirectional guidance* to *mutual negotiation*. Our evaluation reveals that YFMs and OAs actively interact regarding the dual goals of "learning" and "problem-solving" (Section 5.2.1). In traditional technical support model, YFMs predominantly serve as knowledge providers, while OAs remain passive recipients. Their interactions are limited to YFMs' instructions and OAs' following, which often leads to conflicts due to the lack of mutual understanding and communication [68, 86]. In contrast, with WePilot's assistance, such unidirectional knowledge transfer is expected to transform into a more dynamic negotiation process: OAs can express their learning preferences and needs, and YFMs adjust their support strategies accordingly. WePilot takes over YFMs' initial instructions, enabling OAs to receive guidance through a

neutral and natural interface rather than direct instructions, which demonstrates potential for reducing interpersonal conflicts persisting in the traditional process [36, 55].

- **Expanded Interaction Scope**: After adopting our system, the interaction scope between OAs and YFMs has broadened from *technical instruction* to *broader casual discussions*. For instance, conversations about font size adjustments naturally evolved into discussions about eye health, and setting up message notifications changed into broader dialogues about communication preferences (Section 5.2.1). These technical support sessions served as catalysts for more comprehensive intergenerational exchanges [50]. Such changes demonstrate that technical support extends beyond problem-solving to strengthening intergenerational bonds [66]. By connecting technical issues with daily life scenarios, WePilot shows the potential to create opportunities for intergenerational communication between YFMs and OAs [50].

6.1.2 Weakness. While the introduction of chatbot offers several benefits for both YFMs and OAs, it brings some challenges to intergenerational interaction. For instance, there is a reduction in direct communication opportunities between YFMs and OAs. It can weaken the established functions of emotional support and relationship maintenance in intergenerational interaction, as highlighted in previous research [21, 55, 96]. Although WePilot attempts to compensate this issue by encouraging communication after problem solving (Section 5.2.2), such "designed interaction opportunities" cannot always achieve the intended effects. It will bring adaptation difficulties for OAs and YFMs in fully autonomous settings, potentially leading to feelings of disconnection [21, 48]. Mitigating this drawback presents complex challenges. The essential is to determine the task boundary between chatbot and OAs/YFMs, i.e., letting chatbot take over some guidance and interaction tasks while ensuring the necessary interactions between OAs and YFMs. The appropriateness is difficult to control since chatbot's excessive involvement can reduce YFMs and OAs' communication, while insufficient involvement fails to effectively reduce either party's burden. This challenge echoes the current research topic of human-AI collaboration in HCI and CSCW fields, with the aim to coordinate tasks between humans and chatbots in different scenarios [7, 91, 92].

According to the intergenerational communication theory [95], the transition from synchronous interaction to asynchronous interaction potentially weakens emotional connections and diminishes interaction quality. Social presence theory further suggests that in technology-mediated remote interactions, the perceived presence of interaction partners significantly influences communication experiences and outcomes [29]. Based on these theoretical insights, we propose several directions for future research:

- Task Allocation Strategy: Further classify the tasks in OAs' smartphone usage problem-solving into problem-oriented sub-tasks (chatbot undertakes) and communication-oriented sub-tasks (YFMs undertake). This approach could appropriately employ chatbot's strengths in knowledge and accessibility while preserving opportunities for emotional connection between YFMs and OAs.
- Perception and Presence Enhancement: Introduce more appropriate presence indicators to improve mutual awareness between YFMs and OAs, such as highlighted indicators of YFM's identity.
- Additional Emotional Interaction Mechanism: Add asynchronous emotional engagement features as options. For instance, suggesting YFMs and OAs to conduct a discussion around related topics after problem solving.

Overall, the support mode represented by WePilot presents both opportunities and challenges. On one hand, the increased asynchrony and flexibility make technical support more accessible; on the other hand, it brings potential negative impacts on intergenerational interaction. To address this issue, we suggest that future designs should be grounded in theories of intergenerational communication and social presence, developing tools that maintain the efficiency of asynchronous support while preserving intergenerational relationships. This research not only extends CSCW field's understanding of intergenerational technical support but also provides new insights for building more balanced human-AI collaborative support systems.

6.2 Design Considerations and Design Implications

Our research also reveals YFMs and OAs' several concerns regarding intergenerational technical support tools, including technical risks, devolution of learning, inconsistent expressions, and insufficient personalization.

Technical Risks. Although WePilot demonstrated promising efficiency improvements (Section 5.2.2), security issues emerged as a primary consideration, particularly from YFMs (Section 5.2.3). Under traditional remote technical support between YFMs and OAs, identity verification is straightforward and reliable. But when a chatbot is introduced, the identity verification becomes indirect, carrying some indirect risks. Both YFMs and OAs worry about "*How to ensure solutions come from YFMs rather than others.*" This concern aligns with the worries of previous research emphasizing OAs' vulnerability to digital security risks [19, 59, 80, 82], especially in automated operations. Based on this, we suggest that future research to consider some security verification strategies like identity verification, ensuring the authenticity of supporters and credibility of operations.

Devolution of Learning. Another consideration is the trade-off between automation convenience and learning efficiency. Our findings indicate that OAs and YFMs cannot reach consensus on the *one-click-go* mode usage (Section 5.2.3). YFMs expressed concerns regarding two critical issues: diminished learning engagement and excessive tool dependency. The former means automated operations will reduce OAs' learning opportunities, and the latter means the increasing reliance on automated tools can lead to digital literacy reduction and "lazy mindsets"[71, 72]. This contradiction reflects a fundamental challenge in the design of teaching systems: balancing task completion and skill development [1, 65, 70]. Recent research in scaffolded learning [84] demonstrates that progressive support reduction can effectively maintain both operation efficiency and learning outcomes. Based on these insights, we recommend: 1) adjusting automated levels according to OAs' progress and task complexity; 2) introducing features that encourage OAs' reflection and understanding in automated operations.

Inconsistent Expressions.: Our evaluation reveals challenges in maintaining consistent interactions, particularly in concept explanation (Section 5.2.3). Inconsistent metaphor usage (e.g., describing plus icon as a drawer last time but as a menu this time) creates cognitive confusion for OAs, resulting in additional cognitive burden during learning. To address this challenge, we suggest: 1) emphasizing the role of historical conversations to create user-specific metaphor libraries; 2) utilizing techniques like Chain of Thought[93] to stimulate LLMs to infer the most proper metaphor relationships and keep consistent. Through these approaches, the system can adaptively maintain conceptual coherence across multiple support sessions.

Insufficient Personalization: Our evaluation indicates limitations in the current personalization approaches, particularly in concept explanation (Section 5.2.3). Although we attempted to customize explanations based on age groups, this demographic-based approach proved insufficient. Users with high digital literacy feel "*underestimated*" by standardized explanations, while others found metaphors disconnected from their life experiences. These findings confirm the recent doubt about age-based personalized design [8, 28], suggesting the need for more sophisticated user modeling approaches [34, 47, 79]. So future research can consider some personalization strategies like generating explanations according to user's digital literacy and life experience, dynamically adjusting explanations based on user feedback and progress, etc.

6.3 Limitations and Future Work

Although this research provides valuable insights into intelligent smartphone usage support between generations, it has several limitations.

First, our participants came from a single cultural background, limiting our understanding of how cultural differences might influence intergenerational technical support patterns and system performance. In the meanwhile, the short evaluation period restricted our chances to observe users' long-term learning behaviors, adaptation strategies, and sustained engagement. So, in the future, it is meaningful to conduct longitudinal studies across different cultural backgrounds with more diverse participant groups, which would help deepen our understanding of how various cultural and social factors influence intergenerational technical support and enable better understanding of OAs' learning trajectories and long-term engagement patterns.

Second, as mentioned above, our system still has some drawbacks to be addressed, such as inaccurate locating and inconsistent explanations. So future work should focus on developing more robust GUI navigation models to enhance element recognition and interaction guidance accuracy. This may involve exploring alternative visual processing approaches or combining multiple models to improve reliability. Meanwhile, constructing a temporally consistent explanation framework to enhance intergenerational technical support. Specifically, mechanisms should be developed to track and maintain the conceptual relationships across interface elements, thereby ensuring explanatory consistency over time while preserving the semantic connections between interrelated concepts. These improvements will contribute to building more robust and reliable intergenerational technology learning support systems, ultimately promoting understanding and collaboration between younger family members and older users in technology adoption processes.

Third, as a lab-based study, our current findings may not fully capture the complex dynamics in real-world scenarios. For instance, whether the tool promotes OA's willingness to seek assistance[20] when facing technical problems, whether WePilot genuinely alleviates OA's burden[33, 74] in help-seeking and problem-solving, and how its long-time usage affects intergenerational communication[20, 26]. Future work can conduct real-world deployment and then employ longitudinal studies to investigate these questions, which helps obtain more reliable insights and make WePilot's improvements more practical.

7 Conclusion

This paper introduces WePilot, a chatbot-mediated system designed to help OAs and YFMs to collaboratively solve smartphone usage problems. Through a formative study with 21 participants, we identified OAs and YFMs' current experiences and expectations in remote intergenerational technical support, especially three major conflicts between them. After that, we introduced chatbot to mediate the gaps by allowing: (1) YFMs to provide support more flexibly through multiple solution provision methods; (2) OAs to solve problems through detailed learning or quick completion; and (3) OAs to better understand technical concepts through metaphor-based explanations. An evaluation with 12 pairs of OA and YFM showed that WePilot could reduce YFMs' time cost and provide OAs with an intuitive, low-pressure, and efficient support experience. In the future, we will continue to improve this system by introducing more personalization strategies and validate its performance in broader context (e.g., different groups of OAs and YFMs and long-term observation).

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A Original Chinese Figures

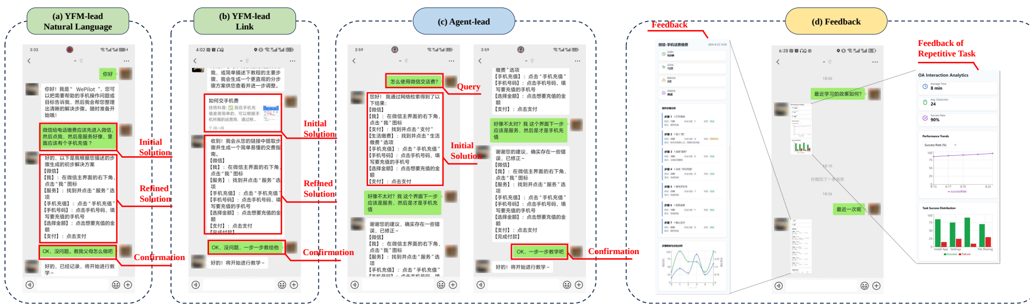

Fig. 9. Interaction interface between YFMs and WePilot, displaying three modes of solution provision and state feedback.

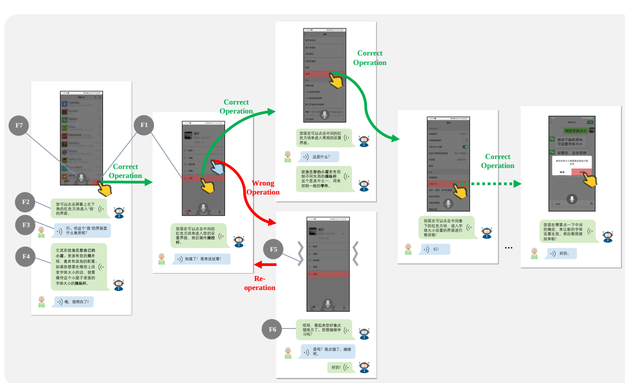

Fig. 10. Interaction process between OAs and WePilot. Green arrows indicate the correct operation paths, while red arrows show incorrect operations and subsequent recovery steps.

Fig. 11. History Help Panel.

B Expectations and System Design

Table 5. Overview of user expectation and system design.

	Expectation and Gap	System Design		Limitation
		Feature/Functionality	**Module**	
OA	Improve the accessibility of support	• **Fea.1**: Incorporating chatbot into the help-seeking interactions between OAs and YFMs	• Solution Finding Module • Operation Guiding Module • Feedback Module	• **Lim.1**: YFMs still need to confirm the solution, which may delay the support if they are unavailable
		• **Fea.2**: Logging support instances for reusing	• Solution Finding Module (Reuse Mechanism)	
	Provide intuitive instructions and guidance	• **Fea.3**: Voice prompts • **Fea.4**: Visual highlight	• Operation Guiding Module (Step-by-step mode and One-click go mode)	• **Lim.2**: MLLM has limitations in locating complex UI elements (icon-based controls without text labels)
		• **Fea.5**: Performing actions step-by-step • **Fea.6**: Using metaphors to translate technical concepts and converting abstract ICT terms into familiar analogies	• Operation Guiding Module (Step-by-step mode)	
	Enhance interactions	• **Fea.7**: Providing visual and audio feedback for correct action and vibration and voice notification for incorrect action • **Fea.8**: Answering questions about interface elements, ICT terms or operational steps and generating comprehensible explanations	• Operation Guiding Module (Step-by-step mode)	• **Lim.3**: Some concept explanations are not coherent or disconnected from OAs' life experiences during interactions
	Offer flexible options	• **Fea.9**: Offering OAs two forms of operation guidance: step-by-step guidance and one-click-go operation	• Operating Guiding Module	• **Lim.4**: One-click-go mode may lead to OAs' diminished learning engagement and excessive tool dependency
YFM	Reduce time and effort	• **Fea.1** • **Fea.10**: Allowing YFMs to just provide brief descriptions or online tutorial resources	• Solution Finding Module (YFM-lead mode)	• **Lim.5**: With YFMs' participation reduces, there may be security concerns such as potential hacking or theft
		• **Fea.11**: Providing automated solution discovery when YFMs do not know the solution well	• Solution Finding Module (Agent-lead mode)	
		• **Fea.12**: Responding to OAs' repeated requests by taking advantage of solution reuse mechanism	• Solution Finding Module (Reuse Mechanism)	
	Provide feedback	• **Fea.13**: Allowing YFMs to get to know OAs' interaction patterns and potential difficulties in problem-solving • **Fea.14**: Allowing YFMs to track OAs' changes over time	• Feedback Module	\
	Maintain participation and connection	• **Fea.15**: Providing a refine-confirm process in solution finding	• Solution Finding Module (YFM-lead mode and Agent-lead mode)	• **Lim.6**: Direct communication opportunities between YFMs and OAs may reduce
		• **Fea.16**: Allowing YFMs to know OAs problem-solving status and changes	• Solution Finding Module (Function Library)	

	Expectation and Gap	System Design		Limitation
		Feature/Functionality	Module	
Expectation Gaps	Detailed Guidance vs. Quick Resolution	• **Fea.3** • **Fea.4** • **Fea.5** • **Fea.6** • **Fea.7** • **Fea.8**	• Operation Guiding Module	• **Lim.2** • **Lim.4** • **Lim.5**
		• **Fea.10** • **Fea.11**	• Solution Finding Module	
	Immediate Needs vs. Belated Support	• **Fea.1** • **Fea.2**	• Solution Finding Module • Operation Guiding Module • Feedback Module	• **Lim.1** • **Lim.6**
		• **Fea.10** • **Fea.11** • **Fea.12**	• Solution Finding Module	
	Complex Instructions vs. Weak Comprehension	• **Fea.6** • **Fea.8**	• Operation Guiding Module (Step-by-step mode)	• **Lim.3**
		• **Fea.10**	• Solution Finding Module (YFM-lead mode)	

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