LifePal: A Mobile Self-Management Tool for Supporting Young People with Autism

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Abstract— **People with autism spectrum disorders (ASD) cope with a life-long condition that can affect communication skills and social interaction. This can lead to feelings of social anxiety, depression and isolation, especially among young adults with ASD. One strategy to support the needs of people with ASD is to facilitate proper structure and organization in the person's daily life. This paper presents a technology solution that promotes a self-management paradigm towards empowering people with ASD to enhance their independence and life skills. 'LifePal' is a smartphone App that provides users with task management, life-logging, reminding, and travel support. The App is supported via a dedicated web portal that promotes collaboration between caregivers and their dependents, towards defining obtainable life goals. The paper presents implementation details of the core platform services and discusses the results from a two-stage evaluation, conducted over a period of 6 months. Based on the feedback from 20 participants (4 parents (Phase one), 8 child-parent groupings (Phase two)), the findings positively support the potential utility of LifePal, however, highlight the importance of delivering sufficient user training to support adoption.**

Keywords— **Autism Spectrum Disorder, Self-Management, Education, Assistive Technology, Personalisation, Near Field Communication.**

I. INTRODUCTION & BACKGROUND

The adoption of smartphone Apps as low-cost tools to support the daily living of young people (aged between 12 - 18) with Autism Spectrum Disorders (ASD) is becoming common practice [1, 2]. Autism is a lifelong pervasive developmental disorder that affects how a person can communicate and relate to their surrounding world and is usually diagnosed in children by the age of three [3]. People with ASD typically experience difficulties in three areas: namely social imagination, communication and social interaction [4]. These difficulties can lead to issues in adaptive functioning, resulting in challenging behaviours such as increased aggression and hyperactivity and social isolation from peers. These issues can also form a barrier to learning within educational environments, which can have a detrimental affect on a young person's confidence, overall wellbeing and mental outlook on life [5].

There is therefore a recognised need for effective intervention and support to reduce the risk of children and young people with ASD from being excluded from education [2]. Research shows that children with ASD and other special education needs currently face higher rates of exclusion and poorer educational outcomes than their peers [6]. While a cure for ASD does not yet exist, several scientifically validated approaches such as Applied Behavioural Analysis (ABA) have been established to increase socially significant behaviours, such as communication, language and self-management skills, whilst reducing challenging behaviours. Accompanying approaches such as ABA, there has also been a growing interest in the use of technology to increase social and education skills, and to improve quality of life for young people with ASD. It is well reported that people with ASD relate well to technology and view smartphones, in particular, as a high-status device. This attraction to technology can help to promote adoption and provides a mechanism to deliver safe and personalised intervention support [2]. There exists, however, relatively little published literature, which focuses on the use of smartphone technologies to aid the self-management of ASD [2].

In recent years, several technological tools have emerged, which report to provide support tools that allow caregivers and educators to set-up, manage and deliver structured interventions. The Helping Autism Diagnosed Navigate and Develop Socially (HANDS) project [7], for example, was developed as an e-learning toolkit, consisting of a series of mobile web applications to aid teachers in creating personalised interventions to suit the needs of teenage students with ASD. Similarly, the MOSOCO (Mobile Social Compass) project [8] was developed as an assistive smartphone application that makes use of the Social Compass training curriculum to help children with ASD develop their social and communication skills in real-life scenarios. The application uses both augmented reality and visual communication aids to deliver a fully interactive experience. The BMAC project [9] developed a smartphone App to enable parents of young children with ASD to systematically maintain records of observable behaviours within the home setting. These records were then mined for patterns in the associated behavioural cause(s) and effect(s), via a supporting web portal, to support ongoing behavioural interventions. Other research [10], [11] has reported on the use of mobile technology as an instructional support for managing daily tasks and improving life skills. Beyond these re-

ported investigations, there exists opportunity to combine interactive behaviour recording with ICT-enabled self-management of activities, to promote everyday independence and quality of life for young people with ASD.

The project associated with the current paper is funded by Big Lottery Fund, UK [12] and benefits from expertise through the involvement of psychologists, behavioural scientists, computer scientists and application designers. The research is coordinated by a local Autism charity [13] and is aiming to investigate ICT-based approaches to increase the inclusion of young people with ASD in education, as well as analysing the benefits of mobile-based technology solutions to increase user independence, enhance core life skills and promote the self-management of daily tasks. This paper describes the developed technology platform and presents initial feedback from an evaluation with end users.

The remainder of this paper is structured as follows: Section II introduces LifePal and presents the system architecture, interface design elements and key features of the LifePal App. Following this, a detailed description of the implementation of LifePal and key underlying technologies are presented in Section III. Section IV outlines the two stages of user trials that have been undertaken to evaluate the work presented and Section V concludes the paper with a summary of future work in this area.

II. LIFEPAL: SERVICE OVERVIEW

LifePal is a technology solution that provides daily activity support to young people with ASD, helping them to organize, for example, their morning routine, providing them with reminding prompts, supporting routine reflection at school / home, or providing travel assistance. Four core personalised services are delivered via a smartphone App: task management combined with gamification (positive reinforcement via a reward system) to recognize achievements and encourage and promote engagement; life-logging of emotions and feelings to promote improved understanding of behaviours, thoughts and moods; travel support via geo-fencing and priority calling services to promote independent travel while safeguarding users' wellbeing; and structured reminding support.

A. Core LifePal Components

Figure 1 presents the LifePal core components and communications framework. The LifePal App is the central component, where the user engages daily with the core LifePal services. Through incorporation of both an App (for young people) and supporting web portal (for parents), LifePal promotes collaboration between the parent and

child. This also encourages the parent and young person to support and understand each other, whilst still allowing the young person the freedom and independence they require in their teenage years. A personalised interface contains information relevant to that particular user such as the number of tasks they have scheduled, specific life-log questions or the number of symbolic 'star' rewards they have collected.
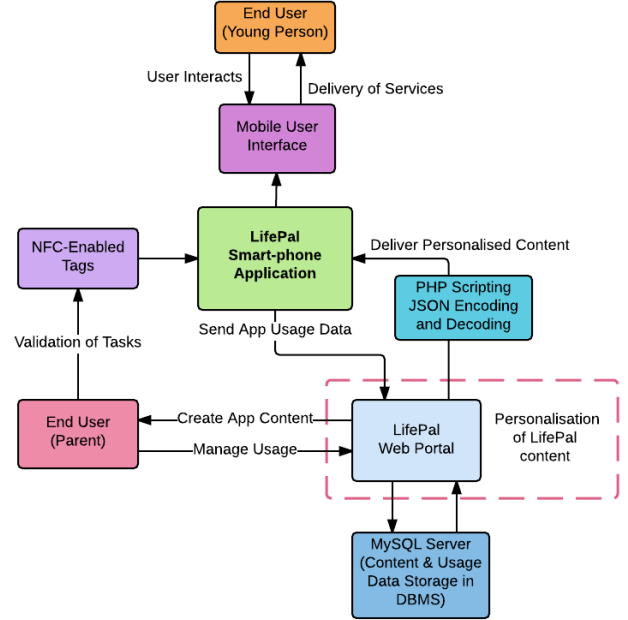

Fig. 1. LifePal core components and communications framework.

LifePal embodies the idea of positive reinforcements [14] that forms an important therapeutic tool in ABA intervention. Positive reinforcement acts to increase the likelihood that certain behaviours will reoccur (e.g. homework completed or maintaing personal hygenie). Contingency contracts are a supporting mechanism that formalise the behaviour(s) or education goal(s) for a young person and the associated reward (reinforcer) that they will receive contingent upon the achievement of that goal. In LifePal, 'star' credits represent these achievements and are earned by the user through a gamification-style interface. Gamification is an emerging approach that engineers real world activities to have 'game-like' features / benefits in a context where game playing does not naturally happen (i.e. completing tasks or recording feelings) [15].

The LifePal web portal acts as a remote entry point to data, synchronised with the App and is used by parents and behavioural therapist to provide support to users. Within the portal, personalized tasks and life-log questions can be defined, geo-fences and priority numbers can be created, reminders set, task rewards values collaboratively agreed and verified and general progress/assessment undertaken.

Contigency contracts are also established with the web portal where suitable rewards (TV time, trip to the cinema) are collaboratively defined. A stars target (i.e. 30 stars) is associated with each contract. Consequently, each task undertaken contributes to a user's star total, which they can then 'cash-in' against rewards.

To prevent abuse of the contigency contract (such as the young person pretending to complete tasks), Near Field Communication (NFC) technology is employed. Each parent has an appropriately coded NFC-enabled tag (i.e. key fob, sticker etc.) with a unique parent ID. Upon request, parents can review tasks indicated as completed within the App, verify tasks were completed appropriately and consequently, approve the awarding of associated stars.

To facilitate the client-server communication between the App and the portal, data from the App is periodically synchronized with a backend MySQL database and includes: location-based co-ordinates, geo-fencing tags, App usage data (task completion details, daily life-logging responses and details of redeemed rewards), timestamps of App launch / log-ins and a record of validated tasks. In instances where network access is unavailable, the App maintains a local copy of all activities until synchronized occurs. .

B. Service Design

This section provides a brief description of the core LifePal services, presented to users as menu options on the main LifePal App screen (Figure 2 (1)).

(1) *A Daily Tasks Management Service.* Organisation and clarity surrounding tasks, as well as specific instructions relating to attaining task completion, is an important requirement for reducing anxiety and managing understanding among people with ASD. LifePal integrates a daily schedule service of personalised tasks (Figure 2 (2-3)) and task-steps that parents and children can collaboratively establish via the web-portal. A record of task completion is then maintained via the App.

(2) *A Daily Life-Logging Service.* Accurate and ongoing behavioural data collection is at the center of informed ASD intervention and LifePal supports this process through a personalised life-logging service (Figure 2 (4)). This service augments traditional therapist-led approaches by empowering young people with ASD to maintain observational data about themselves. Personalised questions, managed via the web portal, can target and capture ongoing mood, behaviour and thoughts at periodic intervals, towards enhancing understanding of the function of behaviours.

(3) *Gamification and Positive Reinforcement.* LifePal has been designed to encourage the self-management of tasks and to promote independence through the completion of personalised activities. Positive reinforcement forms an important element in shaping behaviour. As highlighted, LifePal embraces the notion of gamification to support reinforcement where upon satisfactory completion of tasks, star credits are awarded to the user. Stars can ultimately be redeemed to attain pre-established rewards via the App.
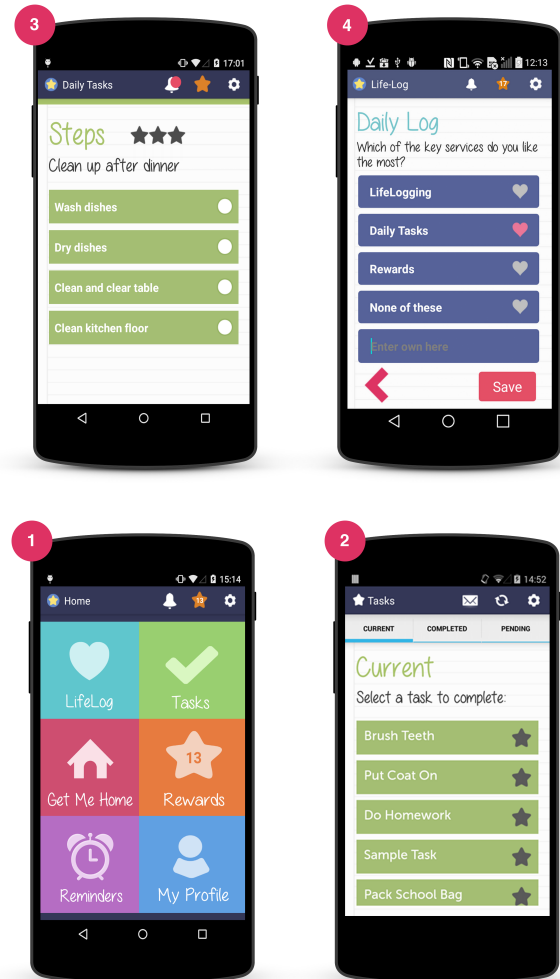

Fig. 2. Screen captures of the LifePal App solution, where (1) shows the main home screen of the App, highlighting the core services, (2) presents an example of a set list of tasks, (3) highlights sample steps within a task and (4) presents an example of a daily life-log screen.

(4) *Contactless NFC parent validation.* LifePal utilises NFC technology to allow parents to unobtrusively validate the completion of tasks undertaken by their child. This method encourages daily face-to-face interaction by parents and children, as parents must review the record of completed tasks, via their child's smartphone. NFC offers significant advantages over traditional passkey validation, as the technology requires very close proximity with the tag-holder therefore reducing to potential for tasks to be ap-

proved without the parent's awareness. A record of validated tasks is synchronized with the web portal.

(5) *Location-based Services and Reminders.* Young people aspire to having some freedom to travel independently, however, due to the nature of ASD, parents often report concerns surrounding wandering or the potential for their child to become confused or lost. LifePal provides a personalised geo-fencing service to pseudo-monitor a young person's location. Via the web portal, caregivers can set-up individual 'hotspot' locations and establish geo-fences boundaries to surround these locations (Figure 3).
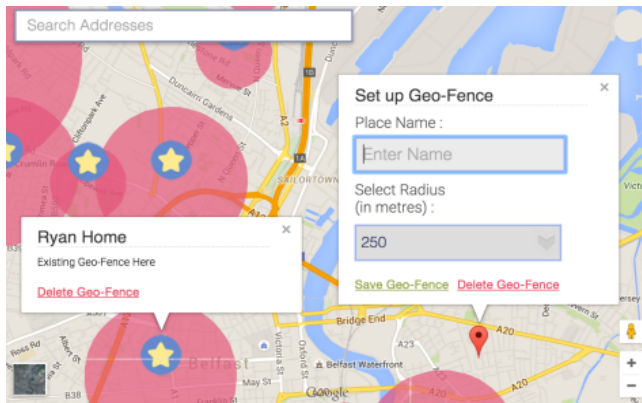

Fig. 3. Using the web portal, parents can create personalised geo-fences and receive automatic alerts if their child transitions between zones.

For example, a parent may establish a hotspot called 'Auntie Kate's House' within the web portal and indicate a radius for the geo-fence to be 250 metres. Geo-fence boundaries are stored on each user's smartphone and LifePal continuously monitors available location-based information. If a young person leaves a specific hotspot radius, a parent is notified via SMS. This service can help parents keep track of their children and notifies them if their child appears to be lost or moves away their expected location.

(6) *Emergency Priority Calling.* LifePal enables parents to set up personalised emergency contact numbers on the web portal. These contacts are easily accessible by the young person via their smartphone, where the calls are prioritised according to the order of preference as set by the parent. This enables quick access to contacts if the young person is distressed or in need of urgent help.

III. IMPLEMENTATION

The LifePal App was designed to run on Android 5.0 (Lollipop). The initial design screens for the App were produced using Adobe Photoshop CS6 and translated into Android Studio (Version 0.9) for implementation of the core App services. The App was prototyped and tested on an LG G3S Android-enable smartphone,. LifePal integrates several APIs, for example, the Google Maps API was used primarily for geo-fencing and location-based services, and Google Cloud Messaging (GCM) services were used for notifications and SMS.

The web portal (Figure 4) was developed using Web 2.0 technologies (HTML5, JavaScript, JQuery and CSS3) and communication with the App was facilitated via PHP. Data storage is via a MySQL database. The portal is used as both the content management system and access point to content storage, where details of completed tasks or responses to behavioural life-logging are presented via dashboard themed interfaces. Access is via password-protected log in. Parents are trained to adopt responsibility for creating personalised content for their child, manage existing content and track their child's usage on a daily basis.

Fig. 4. Screen capture of the LifePal web portal dashboard screen.

IV. USER EVALUATIONS

Following ethical approval from Ulster's Research Ethics Committee, LifePal was deployed over a period of six months within a two-stage user evaluation, involving 20 participants. During phase one, 4 parents of children with ASD were recruited. In phase two, 16 further participants were recruited, involving 8 parents and 8 children with a diagnosis of high functioning ASD.

A. Phase One: Pilot Study

Phase one aimed to evaluate service provisioning, usability and user interaction / experience of the LifePal App and web portal. Given the experimental nature of the services developed, we elected not to directly involve younger users in the phase 1 evaluation, to reduce the risk of anxiety that may have been associated with use of the services. Instead, we postulated that parents had sufficient insight into their child's individual needs in order to critique the feasibility of the LifePal services. Consequently, parent participants were

invited to evaluate three specific aspects of the LifePal over a 2-4 week period, namely the: (1) App, (2) web portal and (3) NFC service. Using pre-questionnaires, all participants rated themselves as experienced smart phone / desktop users in accessing the www and basic applications. Additionally, they reported having broadband available in their homes. None of the participants had previous exposure to NFC technology. Based on the initial information provided to participants about LifePal, all expected their child to be able to use the service.

During the evaluation, daily App usage including task management, life-logging and access to rewards was encouraged. Participants undertook 'simulated' tasks and life-logs that did not divulge personal information but which mimic the role of a child. Participants accessed the web portal to create personalised content to be for delivery via the LifePal App. The NFC service was evaluated by requesting participants to validate completed tasks and subsequently, cash-in awarded stars for simulated rewards. Throughout the evaluation, participants maintained App activity logs as well as completing pre-and post-evaluation questionnaires.

Table 1 presents a summary of the feedback received from participants taking part in phase one, where all participants commented on the utility of LifePal as an aid to support interventions for those with ASD. In general, participants favoured the tasks management service and the ability to personalise rewards but reported difficulties using NFC for validation. Attributed issues related to high-level technical problems with the smartphone (such as screen freezes or NFC tag corruption) and usability issues (such as placement of options, duplication of reminders appearing on the portal etc. Participants reported both the Life-logging and tasks features as very easy to use. Results from questionnaires indicated that participants would be willing to pilot LifePal with their children, highlighted overall inexperience with NFC technology, but positively demonstrated their willingness to learn. Phase one also served as an opportunity to provide training to parents in preparation for the release of the tool on their children, in phase two of the study.

B. Phase Two: Follow up Study

Phase two involved both young people and their parent(s). In total, eight pairings were recruited to use LifePal, for a period of up-to one month. Only two of the groupings reported to use an existing paper-based system to support self-management of tasks. Young participants were aged between 12-18 years old and have a diagnosis of high functioning ASD. They were invited to regularly use the LifePal App and requested to flag potential concerns or issues observed. During this time, parent participants were requested to manage the web portal and to create and edit content for/with their child. Parents were also requested to keep track of activity completion, record any usability or technical and provide a critique of the services provided.

Here, we present a summary of analysis emerging from this evaluation, which ended in late December 2015. Approximately 70 days worth of data was recorded during which, 290 life-logs and 61 tasks were recorded within the App. Of the eight groupings, four participants showed sustained use of the system, however, all participants provided relevant feedback. Among the most highly rated features were both life-logging and the rewards service which included the facility to generate a personalised contract between the parent and child. One parent reported particular interest in both the messaging and geo-fencing service. Scope for improvements mainly focused on the need to provide a repeat-scheduled task feature for those frequently occurring tasks. This is something, which is being actively implemented into the platform. While the design of the LifePal App and web portal were highly rated, two of the pairings noted that customisation of the App colour scheme may make it more attractive to older teenagers. Another interesting observation was that younger users found the App easy to use while parents reported a learning curve associated with the web portal. In terms of qualitative feedback, parents praised the concepts of the platform, highlighting the advantages of delivering services via technology in comparison with paper-based approaches. They also indicated that LifePal added structure to their child's day, allowing them to know what lay ahead and provided them with a safe space to life-log in a non-verbal way.

Table 1 Summary of phase one evaluation feedback for LifePal.

ID	Duration (days)	Tasks Completed	Life-Logs Completed	Rewards Used	Favourite Feature(s)	Reported Errors	Most Difficult Feat.
Parent_1	14	5	15	11	Tasks/Rewards	0	NFC
Parent_2	26	4	26	2	Tasks/Rewards	14 (Usability)	NFC
Parent_3	31	20	30	22	Life-Logs/Rewards	7 (Usability)	NFC
Parent_4	17	7	31	9	Rewards	3 (Technical)	NFC

V. CONCLUSIONS AND LIMITATIONS

LifePal aims to aid young people to self-managing their ASD, through support for goal setting, reminding, life-logging and travel. While the initial results from LifePal are encouraging, there exists some shortcomings such as the relatively low-numbers of participants and the decreasing engagement observed, over the evaluation periods. In part, these limitations relate to limited resources available to facilitate recruitment, face-to-face training and monitoring of the evaluations. However, maintaining active user compliance and engagement was also challenging. Participation in evaluation studies can be time consuming and families living with ASD already cope with complex and unplanned scenarios, on a daily basis. In Phase one, set tasks were important for the investigators, to glean insight into the value of LifePal but they were, to an extent, simulated.

Consequently, some participants indicated that they did not have sufficient time to devote to the evaluations and felt overwhelmed by the accompanying evaluation paperwork. Similarly, in Phase two, participants were instructed to engage with specific LifePal services 'at least once' and it would appear that some of the participants took a literal view of this request.

LifePal is intended to be used as an everyday support tool along the ASD journey and as such could require different levels of usage at different time points in a person's life. As such, several weeks or even months of usage and collaboration with ABA support teams may be needed to validate LifePal as a ubiquitous solution that a family comes to depend upon. Consequently, more natural and passive evaluations, exploring trends in usage and service access, over a longer period is an interesting proposal.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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