Usability Study on Mobile Processes Enabling Remote Therapeutic Interventions

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***Abstract*—Many studies have revealed that therapeutic homework is beneficial for the efficacy of therapies. Interestingly, the latter have been less supported by IT systems so far and, hence, therapeutic opportunities have been neglected. For example, mobile devices can be used to notify patients about assigned homework and help them to accomplish it in a timely manner. In general, the use of mobile devices as well as their sensors seem to be promising for the support of remote therapeutic interventions. In the Albatros project, we have been developing a framework that enables domain experts to flexibly define the homework required in the context of a remote therapeutic intervention. More precisely, the various tasks of a homework can be specified as a mobile process, which is then run on the mobile device of the respective patient. To realize this vision, a configurator component using a model-driven approach was developed. In particular, the Albatros configurator shall relieve domain experts from complex technical issues when defining a homework. The study presented in this paper investigates whether domain experts are actually able to use the configurator component. In particular, the study revealed three insights. First, basic interventions can be easily defined with an acceptable number of errors. Second, for defining complex interventions (e.g., using a sensor when performing an exercise) several issues could be identified that will contribute to improve the Albatros configurator. Third, additional studies are needed to evaluate the overall mental effort of domain experts when using the configurator. Altogether, the Albatros framework may be a reasonable alley to empower domain experts in creating homework in the context of remote therapeutic interventions.**

***Keywords*-Therapeutic Interventions, Mobile Processes, Mobile Assistance, Mobile Therapy, Usability Study, mHealth**

I. Introduction

The use of therapeutic interventions constitutes a fundamental pillar for increasing the efficacy of therapies in many cases. In psychotherapy, for example, therapeutic homework increases the therapy efficacy [1], especially when patients quantitatively and qualitatively comply with their assigned homework [2]. Therapeutic homework helps patients to transfer the content learned in a therapy to their daily life. Currently, the management of homework is less supported by IT systems. However, the latter offer promising perspectives that should be exploited to address existing drawbacks [3]. To monitor whether or not a patient is actually performing a homework, for example, is very difficult without any support by IT systems. As a consequence, therapists usually evaluate the outcome of homework only retrospectively when meeting the patient in a personal session, but not prospectively between two sessions. However, if the period between two sessions is rather long, the outcome of a homework is usually discussed too late. Consider Fig. 1: In a personal treatment session, a psychotherapist assigns three homework tasks to a patient and they jointly specify the contexts (e.g., in the morning) for this tasks. Without any monitoring or feedback during treatment sessions, the psychotherapist can only review and - if necessary - adjust the homework in the next personal treatment session. As a drawback, this might lead to an unnecessary extension of the overall duration of the therapy. As the waiting times for receiving a psychotherapy are usually long, the goal should be to optimize therapy durations. In this context, the use of IT systems offers promising perspectives. For example, when using smartphones to report in real time, between subsequent sessions, whether a homework task can be performed successfully or is perceived as too difficult, the overall procedure can be managed in a more efficient way. Recent studies have confirmed that therapists crave for an IT support of remote therapeutic interventions [4]. In the Albatros project, we developed a framework that copes with drawbacks in the context of therapeutic interventions as described.

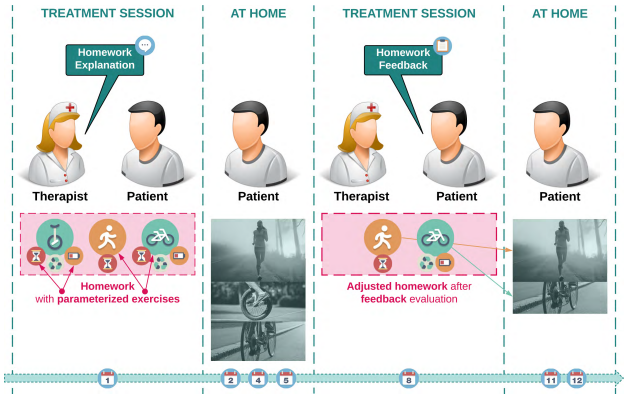

Figure 1. Treatment Phases

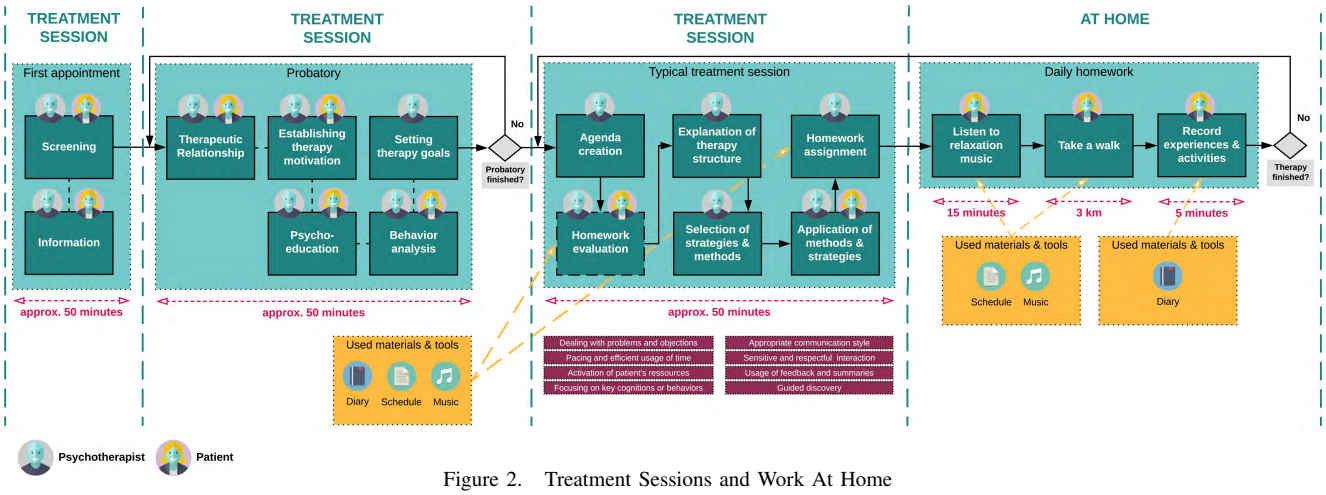

Figure 2. Treatment Sessions and Work At Home

In particular, the framework provides the following features:

- It enables domain experts (e.g., psychotherapists, physiotherapists, or physicians) to flexibly create and adjust therapeutic homework themselves.
- It enables domain experts to manage the homework with their patients through the help of smartphones.
- It supports patients to share feedback with domain expert, again supported by smartphones.
- It supports patients in properly adhering to the assigned homework based on reminders as well as instructions on the smartphone.

To enable these features in a robust and flexible manner, Albatros relies on three fundamental pillars [5]:

- A *meta-model* was developed that captures the therapeutic procedure technically.
- *Mobile processes* specified with this meta-model are used to provide the homework tasks on the patients smartphones. On one hand, mobile processes are the core concept of the aforementioned features. On the other, mobile processes allow for the proper support of a variety of homework.
- A *configurator component* was developed that empowers domain experts to define and adjust mobile processes on an abstract level.

The overall technical framework [6] and the concepts we developed based on the mobile processes have been already introduced in [5]. In this work, we present results on a study that was conducted to evaluate whether the configurator component (i.e., the component to create mobile processes on an abstraction level) is appropriate to empower the study participants to create therapeutic homework tasks themselves. The study results indicate that the concept used for the configurator is feasible in practice. Furthermore, the revealed results indicate that mobile processes constitute a proper technical concept in this context. The remainder of this paper is structured as follows: Section II discusses the structure of therapeutic interventions and Section III presents the developed configurator component as well as the benefits of mobile processes. In Section IV, the design of the study is summarized, whereas Section V discusses study results. Finally, Section VI discusses related work and Section VII concludes the paper with a summary and an outlook.

II. Treatment Sessions and Work at Home

Usually, a therapy starts with a personal meeting between therapist and patient. During this meeting, the therapist assesses a comprehensive anamnesis and establishes a therapeutic alliance. Then, the therapist compiles a therapy plan that consists of therapeutic interventions and the required sessions to achieve a positive effect for the patient. Concerning the therapeutic interventions, two intervention types are created by therapists – the ones applied during the personal meetings and the interventions to be accomplished by the patient between the personal meetings ("homework"). Fig. 2 summarizes the overall homework procedure. Patients need to process the assigned homework tasks as well as memorize and perform them. As many patients have difficulties to concentrate or memorize, and show a reduction of energy as well as a decrease in activity as symptoms, the homework procedure is error-prone. Thus, proper IT support is crucial in this context.

III. Mobile Processes and the Configurator

The mobile processes we use as the basic artefacts to support homework cover the requirements we elicited in practical projects with therapists [6], [5]. As these requirements need to be covered by the configurator, we briefly summarize them along three categories: First, a number of requirements related to homework need to be addressed, e.g., therapists should be able to assign media elements to a homework, which are then presented to the respective patient on his mobile device. Second, requirements related to the context of a homework need to be considered. Particularly, context allows coping with the demands of therapists on one hand (e.g., a homework to be performed after getting up) and enabling researchers to gather context-sensitive data on the other. Third, requirements related to mobile devices need to be covered, e.g., the mobile device shall provide

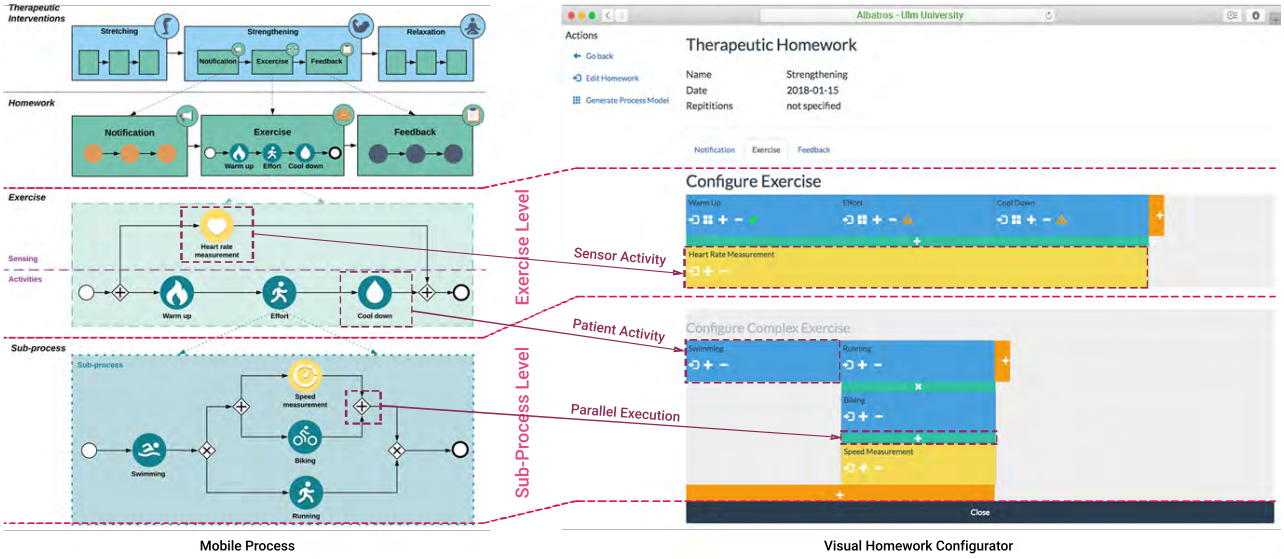

Figure 3. Mobile Processes and Developed Configurator

media elements to assist the patient when performing a homework. Altogether, 14 requirements [6] were identified that are considered by the mobile process model.

Furthermore, the configurator we developed shall allow for defining the logic of mobile processes at a rather abstract level in order to relieve domain experts from complex specification tasks being out of the scope of their therapeutic work. Consider the left hand side of Fig. 3, which shows how therapeutic interventions can be represented in terms of a mobile process. To be more precise, the depicted mobile process comprises several process fragments. Each fragment, in turn, corresponds to a specific homework whose execution order is specified by the mobile process. In general, a homework encompasses three process steps, i.e., a $notification$ step, an $exercise$ step, and a $feedback$ step. Thereby, the execution order of these steps is as follows: $Notification \rightarrow Exercise \rightarrow Feedback$. For example, a patient is $notified$ about an $exercise$ to be accomplished and then needs to provide $feedback$ to the therapist. In practice, each of these steps is executed on a mobile device. Note that the concrete realization on such a device depends on the specific homework scenario on one hand and the used mobile platform on the other. Finally, a context is assigned to homework in order to meet practical execution requirements.

The analysis of the practical scenarios revealed that exercises require a fine-grained itemization. Due to the latter, the introduction of a guiding mobile process model was required. More specifically, therapists might want to create exercises based on a pre-specified set of activities. For example, an exercise may contain a warm-up activity, an effort activity, and a cool-down activity. In addition, therapists may want to utilize the sensors of the mobile devices in this context. Thus, we integrated a context-based sensing activity with exercises. Note that the practical insights further revealed that the notification step as well as the feedback step need to be itemized in the same way as the exercise step. As the notification and feedback steps are similar to the exercise step, we omit a detailed discussion for them. Moreover, practical insights further revealed that a more flexible concept is needed for activities to meet the requirements of therapists. Therefore, we developed simple as well as complex activities for defining exercises. While simple activities solely contain one activity being performed by a patient, complex activities may be substituted by subprocesses. The latter, in turn, may be characterized by complex activity structures. For example, activity *effort* is substituted by a subprocess comprising activity swimming, followed by a decision on whether *swimming* shall be followed by activity *biking* or activity *running* (cf. Fig. 3). If activity *biking* is chosen, biking speed can be measured by a context-based sensing activity. Note that the context value needed for evaluating whether to choose *biking* or *running* is specified by the therapist after discussing this with the patient.

Fig. 3 summarizes the levels of the mobile process model, which meets the demands of therapeutic interventions in the context of homework. In particular, the levels of a mobile process shall guide the therapists in performing the required steps in the right order. For example, therapists must not create decisions on exercise level. In turn, decisions are only allowed when using complex activities. For each level of the mobile process model, in turn, the configurator provides both simple and complex activities. Their features cover most of the scenarios required in the context of therapeutic interventions. For example, the configurator provides activities measuring the heart rate or filling in a questionnaire. Note that therapists can only create therapeutic interventions based on the available activities. In practice, however, there

exist scenarios in which the given functionality is not sufficient. For example, therapists may want to use an activity to measure skin conductance, while filling in a questionnaire in parallel. In such cases, an application developer needs to implement the respective feature. Afterwards, the application developer releases the implementation to the modeling component in order to enable therapists to use the new feature. In this context, two aspects need to be emphasized. First, the mobile process model has turned out to be a powerful instrument for application developers to implement new features. In particular, the complex activities enable them to decide in what way missing features can be quickly and robustly realized. Second, the mobile process model has covered all practical scenarios we had identified. Therapeutic interventions created with the configurator will be then transformed to executable processes running on mobile devices. In this context, an automatic transformation procedure ensures that resulting mobile processes are correctly executed by a mobile process engine (e.g. [7]). Therefore, we realized a transformation feature for the configurator. In the final step, a mobile process will be deployed to a mobile application that we implemented. Our realized mobile application uses a mobile process engine to execute the mobile processes. The explanations have shown that mobile processes constitute a powerful instrument for capturing homework. However, the coverage of all the aspects discussed in this section result in a high complexity to create the respective mobile processes. Consequently, as we aim to empower therapists to specify and create homework themselves, a configurator became necessary that abstracts from complex technical details. Consider the right hand side of Fig. 3, which depicts an exemplary screenshot taken from the developed configurator component. It shows how the mobile process levels are reflected by the configurator. Although the configurator relieves therapists from many technical decisions, still a lot of operations have to be accomplished. Therefore, we conducted a study to answer the question whether the configurator is usable for study participants.

IV. Study Design

Fig. 5 shows the overall study design we applied. As only few comparable studies exist [8], we had numerous discussions with domain experts to figure out how to measure the applicability of the configurator. Finally, we decided to follow the concept called Chinese whispers [9]. Accordingly, the overall study was conducted in two phases, i.e., the study comprised a description as well as a modeling phase (cf. Fig. 5). In the description phase, we selected four homework tasks with different levels of complexity. The latter means that the mobile processes required for the four homework tasks have different levels of modeling complexity, i.e., Homework 1 shows the lowest and Homework 4 the highest complexity. Note that we discussed the mobile processes with process experts to ensure that they fit to the considered scenario. These four models were presented to 28 participants who had to create textual descriptions of the four models (i.e., each participant created all four model descriptions). The textual descriptions constitute the whispers handed over to 28 other participants in the second phase; i.e., the modeling phase. In the modeling phase, then, each of the other 28 participants had to create the four mobile process models based on the textual descriptions. During the modeling phase, the configurator recorded the following three aspects for each participant and each model: First, it records the errors the participants made regarding the number of activities used to represent the exercises of the homework (e.g., using three activities where only one is required). Second, it records the errors the participants made regarding the used decision connections of a mobile process (e.g., using an AND-split decision instead of the required OR-split decision). Third, it records the errors the participants made regarding the used activity types (e.g., using a sensor activity instead of a non-sensor activity). Fig. 6 gives insights into the demographic data of the participants. As the latter had to create process models, even though on an abstract level, we asked them about their experience with creating process models (cf. Fig. 6). In this study, we mainly involved students from Ulm University. However, we also involved participants from industry. Altogether, the

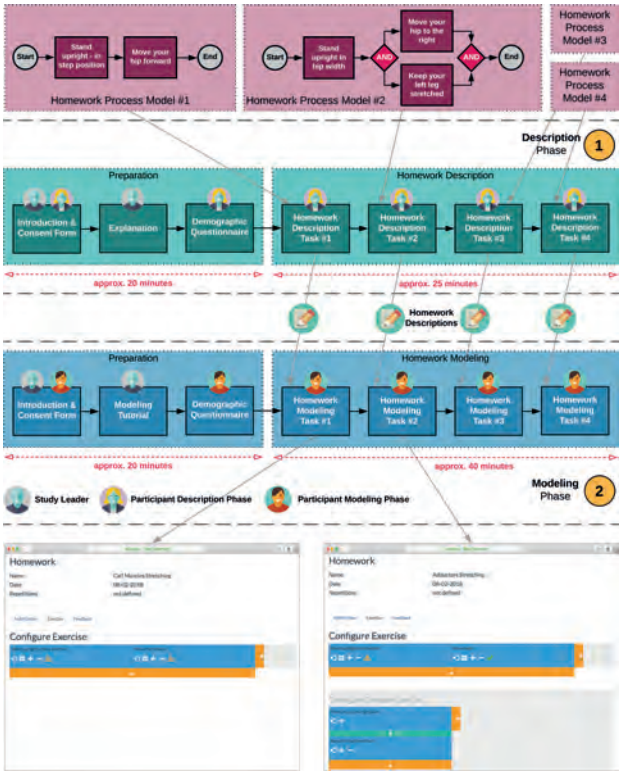

Figure 4. Study Design

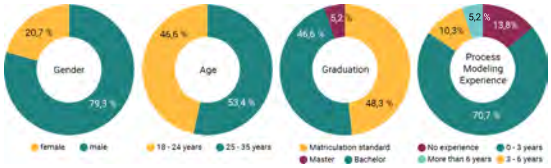

Figure 5. Demographic Data of the Participants

		F-value (degrees of freedom)	P-value
Error Categories	**Wrong Activities / Exercises**	105, 51 (1.83)	<.0001
	Wrong Logical Decisions	135, 67 (1.83)	<.0001
	Wrong Activity types	16, 81 (1.83)	.0001

Table I
STUDY RESULTS

study design was positively perceived by the involved 56 participants. This perception can be observed by answers to the questions we asked each participant afterwards. Moreover, by using this study design, we tried to reveal the following aspects: First, we raise the question whether or not it is appropriate to express homework in terms of mobile processes. This is reflected by the first phase of the study. Second, we raise the question whether or not there are indicators based on the made errors that may show that the mental effort is overall on a reasonable level using the developed configurator. Third, we raise the question, even though complex mobile processes cannot be properly modeled by the study participants themselves, whether the configurator is a suitable instrument to be used by IT experts to create these complex models in an easy and practical manner.

V. STUDY RESULTS

The following results rely on data that was gathered during the study discussed in Section IV. All statistical tests were performed with R using Version 3.4.4. Mixed model analyses of variance (ANOVAs) with random intercepts were calculated with the amount of errors of the three error categories as dependent variables. To be more precise, we calculated whether the made errors in each of the three error categories (i.e., wrong activities/exercises, wrong decision connections, wrong activity types) change significantly from homework modeling task 1 to 4. The results of the ANOVAs are summarized in Table I and the means of the errors are displayed in Fig. 7. As can be obtained from the results,

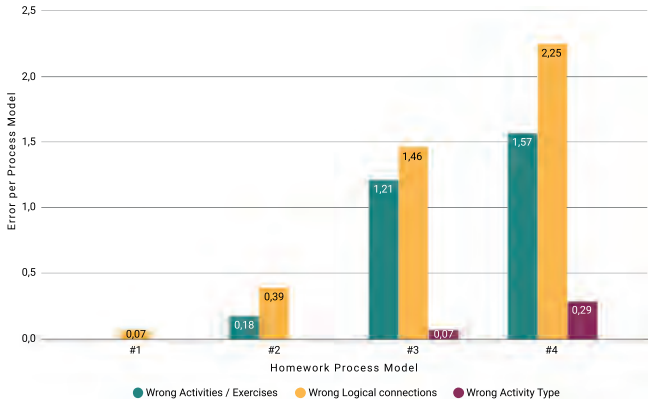

Figure 6. Errors Made for the Homework Modeling Tasks

each error category increases significantly from homework modeling task 1 to homework modeling task 4. The increase of errors from homework modeling task 1 to 4 was expected by the study design using different levels of complexity. The three questions raised in the last section can be answered positively. Concerning Question 1, as all participants were able to model the mobile processes based on the whispers of the first phase, it seems that mobile processes were basically understood. Concerning Question 2, as all participants made only few errors for homework tasks 1 and 2, which already constitute powerful homework definitions. Therefore, the overall mental effort seems to be on a reasonable level. Concerning Question 3, homework tasks 3 and 4 were modeled by the participants with increased errors. To model such a more complex task, a domain expert would need to train himself to be able to create such homework himself or he hands over this task to an IT expert. Even if the latter must create the homework with the configurator, a complex programming procedure can be spared. Note that we do not involve therapists in the study. Therefore, a further study with therapists needs to be conducted. However, our first results are very promising regarding the successful use of the configurator in practice.

VI. RELATED WORK

Three categories of related work are relevant in the context of this paper. First, we need to consider *approaches dealing with mobile therapies*. [10] discusses various approaches using smartphones in the context of personal healthcare. Interestingly, the discussed approaches have revealed that current solutions focus only little on mobile therapies. However, the beneficial use of interventions is emphasized by most of them. In line with [10], [4] underlines the benefits of mobile technology for the efficacy of psychotherapy in more detail. In turn, none of the latter approaches presents technical solutions for therapeutic interventions as we developed. Opposed to that, [11] presents three clinical studies in which mobile technology has been used for mobile interventions. For each study, a specifically tailored mobile application is realized. Although [11] shows the usefulness of mobile interventions, a more generic technical solution is omitted here. Second, *approaches dealing with model-driven concepts in the context of mobile healthcare* are relevant. Recently, approaches have been introduced that use model-driven technical solutions in the context of mobile

healthcare. For example, in [12], the QuestionSys approach is presented in which mobile data collection applications can be realized by healthcare experts without the help of IT experts or application developers. Another related model-driven approach is presented in [13]. It comprises a framework, which automatically creates healthcare plans based on a model-driven concept. The healthcare plans, in turn, are then applied to the smartphones. Third, *approaches dealing with homework in the context of psychotherapy* need to be discussed. Numerous related works deal with homework in the context of psychotherapy [14], [1], [15] . However, they mainly address the results of the conducted studies with no particular focus on technical solutions. The potential of technical solutions in the context of therapeutic homework has recently been highlighted [3]. In current approaches, mobile technology is used to support exposure exercises for patients with anxiety disorders [16], [17]. The development of a generic technical solution that supports homework in particular and therapeutic interventions in general, in turn, is currently less considered. Moreover, study results on configurators that enable domain experts to create sophisticated homework do not exist so far.

VII. Summary and Outlook

This paper investigated the mobile process configurator component of the Albatros framework with respect to its applicability. The configurator, in turn, shall enable therapists to create remote therapeutic interventions based on homework running on mobile devices themselves. To address the applicability, an study with 56 participants was conducted. For the study, the participants were separated into two groups, based on a study design following a Chinese whispers principle [9]. The study results revealed that the developed configurator component is a proper instrument to create homework based on mobile processes. However, as this study did not involve therapists, more studies need to be conducted in future work. These studies should also include qualitative interviews to evaluate the acceptability of Albatros by therapists and patients. Altogether, the two general ideas pursued in Albatros are (1) to empower therapists in creating sophisticated remote therapeutic interventions based on homework and (2) to support patients in successfully performing therapeutic homework tasks. Moreover, further work on Albatros will address the 6 essential features that have recently been identified to be important for mobile apps to maximize homework compliance [3]: (1) congruency to therapy, (2) fostering learning, (3) guiding therapy, (4) building connections, (5) emphasizing completion, and (6) population specificity.

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