Socio-technical Design and Embedding of Rebo, the Reflection Guidance Chatbot for Apprentices

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When designing for reflection, individual and social contexts of the users are central to successful outcomes. Based on our experiences with designing educational chatbots as reflective learning interventions for apprentices, we discuss how to tailor the artefact for the shared needs of a group, and consideration of social and technical aspects when embedding reflection in ongoing practice. An educational chatbot takes on a persona that should be motivating and engaging for learners, as well as trigger productive thought processes. Therefore, it must fit the context, speak as if it belongs and be an overall appealing conversation partner to its target user group. Our design cycles involved target end users and end user representatives/domain experts in the following ways: questionnaires and guided interviews, collaborative design (wording, adaptive turns data base for the agent), formal and informal feedback, data from experimental field studies, and eventually, embedding the chatbot into the apprentices' work and learning practice.

CCS CONCEPTS • Applied computing ~ Education • Human-centered computing ~ Human computer interaction (HCI) ~ HCI design and evaluation methods ~ Field studies

Additional Keywords and Phrases: Reflection guidance chatbot, apprentices, workplace learning, human-centered design, ongoing practice

1 INTRODUCTION

When designing for reflection, we want to take as much of an end user's context and experience realm into account as possible, in order to present them with close-fitting, individual reflection guidance. In this paper, we outline and discuss our design approach when developing a conversational agent as reflective learning intervention for apprentices. Rebo, the reflection guidance chatbot for apprentices (see Figure 1), was designed in close collaboration with apprentices (the target group) and apprenticeship supervisors (the trainers and educators of the target group, as well as specialists in their domain). Starting out with investigating the apprentices working and learning environments, a pre-study of apprentices' computer usage and self-efficacy and guided interviews, every step of the design process was tailored to the shared needs of our target group. We furthermore describe how we proceeded with the socio-technical embedding of the conversational agent, enabling the agent to guide apprentices to reflect on their ongoing practice in their working and learning environments. Using our work as starting point, we want to discuss what individual and social contexts HCI researchers should consider while promoting reflection.

Figure 1: Image of Rebo, the reflection guidance chatbot

We start out with a short excursus of relevant background literature and a summary of our reflective learning tool for apprentices, whose design and socio-technical embedding in ongoing practice we describe. We then elaborate on the collaborative design of the reflection guidance chatbots and on steps taken to embed its usage into the target users' ongoing practice. Eventually, we discuss insights on embedding of reflection in ongoing practice, drawing on aspects of contextual design and theories of socio-technical systems design.

2 BACKGROUND

In this work we describe conversational agents that aid apprentices in reflecting on their work. Apprentices are an interesting group of learners to design for because their training entails formal learning sessions as well as informal learning experiences at the workplace. Apprenticeship in Austria (similar to Germany and Switzerland) is a dual form of education where the apprentice gains footing in a company under supervision of an apprenticeship trainer [cf. 14], and in parallel attends compulsory vocational school, mostly over the course of four years [13]. This alteration between different learning settings, makes it particularly important for apprentices to reflect on their practical learning experiences to turn them into integrated knowledge [20].

There are two reasons why it is desirable that apprentices reflect and learn how to reflect. Firstly, reflection directly supports their apprenticeship, as reflection is assumed to support learning. Secondly, reflection is an important skill in adulthood because it is seen as key mechanism to professional lifelong learning. We view reflection as an individual, meta-cognitive process where a learner critically reviews an experience with the goal to learn from it [cf. 2, 4, 19]. The reflection object [16] is defined simultaneously as the experience that constitutes the topic of reflection and the reflection's target. For apprentices reflecting with the conversational agent Rebo, the reflection object is their work practice. Reflecting on their working and learning is intended to help apprentices to learn better [3] as well as improve their reflection and self-regulated learning skills. In self-regulated learning, the impulse for learning stems within the learners and they themselves also set the direction for learning [23]; reflection is viewed as one of its key mechanisms [17, 31]. Further considering the growing importance of lifelong professional learning [19], being proficient in self-regulated learning and reflection will be important in the apprentices' future professional careers [20].

With our reflection guidance chatbots, we stepped in line with numerous computer-mediated reflection tools. It has been argued that designing for reflection is a reference task in human-computer interaction [8] because of its clear distinction to other tasks. Amongst the roles technologies can adopt in reflection [7, 11] are capturing relevant data, giving access to said data or other information relevant for reflection, triggering users to reflect, enabling collaborative reflection and sharing of experiences, and structuring the reflection process itself [12, 21]. Expanding on insights from reflection prompts [c.f. 6], recent studies have, like us, adopted conversational agents as nudge and guidance for reflection [e.g. 10].

3 REBO, THE REFLECTION GUIDANCE CHATBOTS

Rebo, the artefact we designed and describe here, is a conversational agent that guides apprentices to reflect on work-related learning experiences. We developed three versions of Rebo: In the first two versions, apprentices use the agent to reflect on a single task in order to think about how they would like to do similar tasks in the future. A non-adaptive version of this agent, Rebo Junior, was tested to confirm that the dialogue structure is functional [30], and to investigate how Rebo Junior supports apprentices in learning how to reflect over a longer period of time in a field study [29]. This field study also highlighted what a lack of adaptivity means in the long run: Even though the dialogue structure works in the sense that coherent and reflective conversation with Rebo Junior is possible, engagement with the agent drops over time (ibid). Adaptivity was our approach to solve this and we implemented the adaptive agent called Rebo [28] (see Figure 2). It is adaptive in the sense of being able to react to user statements and has also been investigated in a field study (paper in writing). Finally, Rebo at Work[1] [26] is a conversational agent that has a different purpose: Rebo at Work is used by apprentices to reflect on their work experiences (not a dedicated learning task) with respect to the educational goals set for them in the context of their vocational training.

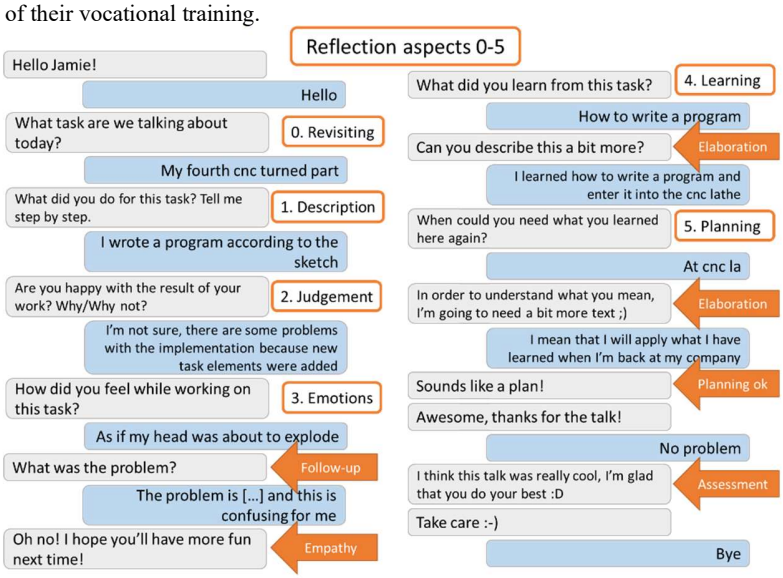

Figure 2: An apprentice reflects on their work with Rebo

Conversational reflection with Rebo is oriented alongside five reflection aspects that contribute to fruitful reflection on learning in ongoing practice: description, judgement, emotions, learning, and planning. Figure 2 shows an example interaction of an apprentice with the conversational agent Rebo. The dialogue elements greeting, goodbye, and the reflection aspects outlined in the numbered boxes, constitute the non-adaptive version, Rebo Junior. They are founded in reflection theory, conceptualized as dialogue structure of a reflective agent, and operationalized for a concrete use case (see [30] for an elaborate discussion on the related concept of a "reflection script"). Rebo's adaptive turns are outlined in orange arrows. They include follow-up questions, empathetic statements, pleas for elaboration, praise, and a feedback comment at the end. In this dialogue, Rebo asks the apprentice to specify which task the reflection is about (0) and to describe it (1). Then, Rebo asks the apprentice to judge the results of their work (2) and elaborate emotions felt during the

[1] https://rebo-at-work.know-center.at/

experience (3). Consequently, Rebo asks what the apprentice has learned from the experience (4) and whether they could see future application possibilities for it (5). The dialogue evolves with various adaptive turns to the apprentice's answers. Finally, Rebo thanks the apprentice for the chat, gives them feedback on it (computed by feature analysis based on reflection analytics, publication forthcoming [28]), and says goodbye.

For the latest version, Rebo at Work [26], we have extended the underlying dialogue structure to split the planning aspect into "planning similar" and "planning adaptation", and we have introduced a problems branch to reflect on issues encountered during the work experience. Furthermore, the agent Rebo at Work is combined with an interactive learning goal widget to help apprentices to self-monitor their learning progress and reflect on their work contextualized as goal-oriented learning opportunities. Please consult cited publications for more details and results.

4 DISCUSSION

In this section we discuss a key question of the workshop "Integrating Individual and Social Contexts into Self-Reflection Technologies". Based on our own past work, we understand there to be two fundamentally different opportunities where **individual and social contexts** can be integrated into (self-reflection) technologies. Firstly, individual and social contexts can methodologically speaking be integrated through considering such contexts at design time (at the time when the technology is designed). In Section 4.1, we firstly discuss the specific measures we took during the design process in order to ensure that we understood individual and social contexts of use sufficiently. Secondly, considering different contexts at design time means that the different contexts should be materialized, in other words be meaningfully addressed in the resulting design. So, we should be able to point to features or design elements of Rebo, that address such contexts. In Section 4.2, we firstly discuss that it is important to understand Rebo not as a piece of technology that works or does not work, but as the technical part of a socio-technical intervention. It is the configuration "users – Rebo – how users use Rebo – social and organizational context of usage and related user activities" that can work or not work. Secondly, we describe in Section 4.2 what this socio-technical embedding of Rebo (Junior) and Rebo at Work looks like. Underlying all these discussions is our understanding that in order to evaluate the benefits of any (self-reflection) technology, it needs to be understood as part of a wider socio-technical system.

4.1 Contextualization through human-centered design

Research in socio-technical systems theory has shown that socio-technical embedding is essential for successful design [5, 15]. Designing digital tools for work and learning that meet demands and are accepted by target users similarly have to be rooted in the target group's working and learning contexts [1, 22]. Following these theories, the starting point for designing computer-mediated learning interventions is the group of learners addressed by the intervention. Further inspired by aspects of contextual design [9] our first focus was on getting to know the domain: the settings and procedures of apprenticeship training, meeting apprentices and apprenticeship supervisors, and observing how they work and learn. As initial phase of the design process, we investigated the target group's computer usage and self-efficacy in form of a questionnaire pre-study [24]. Furthermore, we conducted semi-structured in-depth interviews with apprentices and apprenticeship supervisors [25]. We talked about work and learning settings, manner of working, their community of practice, and apprentices' learner and worker identities. We refer to upcoming publication for results [27].

Through every step and iteration of the design process, close collaboration with apprenticeship supervisors and apprentices' feedback was key. With every new version of the agent, we did not merely add functionality but re-evaluated and improved the preceding version. We made a point of keeping communication channels open throughout each field study and responding promptly to questions or problems reported by apprentices or their trainers. We also monitored

reflective interactions with Rebo, to check back if an apprentice reflected in their free time (instead of during working hours) or react to problems in the conversational flow. For example, when one of Rebo's questions is misunderstood, the phrasing would be re-evaluated and changed.

For a conversational agent, choice of language and manner of talking are essential. The formulations of Rebo's various turns (greetings, questions triggering reflection on various aspects, follow-up questions, pleas for elaboration, empathetic statements, feedback statements, goodbye) were carefully designed. On the one hand, they should be clear, understandable and to the point, to trigger thought processes beneficial to the aimed for reflection aspect. On the other hand, the agent should fit in and match the tone of the setting. We therefore checked and rephrased all of Rebo's utterances with apprenticeship trainers and gathered feedback from apprentices directly. Rebo's visual appearance (see Figure 1) was also thoughtfully designed in multiple steps involving apprentices directly. They, as target group, should like Rebo's image as a further puzzle piece of motivating them to interact with the agent.

With increasing sophistication of the Rebo versions, the agent's data base needed evermore domain knowledge. We analyzed apprentices' previous Rebo interactions to identify frequent answers that would benefit from follow-up questions. For Rebo at Work, we build a new data base with apprenticeship supervisors and workshop trainers that would enable Rebo to link work descriptions entered into the chat to the apprenticeship training's official learning objectives based on the Vocational Training Act [18].

4.2 Socio-technical embedding of Rebo

Rebo Junior and Rebo were embedded in the setting of a training workshop. Multiple small and medium-sized companies fund this workshop as extra training facility for their apprentices, where they are set practical learning tasks (multiple tasks per week) by their trainers. They upload documentation of their work (e.g., photographic documentation) onto their online learning platform using company laptops they are provided with. We know that at this point, they are in a seminar room, they have time allocated for interacting with their learning platform and they have their own computer. This situation was used as ideal setting for triggering reflection, so, with their upload completed, Rebo popped up to guide them to reflect on their work.

Rebo at work is set at the workplace during ongoing work practice at various companies training apprentices. In this setting, apprentices are guided to reflect on self-picked work tasks they themselves consider to be learning opportunities. Apart from varying reflection objects in this informal learning situation, time and place for reflection must be actively made. We outlined lower frequency of reflective interactions (once a month) and worked closely with apprenticeship supervisors to ensure that apprentices are provided with enough time, a quiet room, and a computer for reflection chats with Rebo. In educational as well as workplace contexts, it is crucial to define when and where learners are expected to interact with the agent. In our case, reflecting with Rebo was part of apprenticeship training. This means that apprentices were given time to interact with Rebo during their working hours, they were provided with a computer to access the tool and a quiet space to allow for thought and reflection.

We also considered the apprentices' technical equipment at their respective companies. All apprentices have access to laptop or desktop computers at their place of work, so we optimized the agents for these tools. With Rebo at Work, apprentices did not have a common learning platform, so we provide them with personalized links out of their respective e-learning environment to access the Rebo at Work online tool.

We see that even though the design and aim of the conversational agents is quite similar, their two contexts are utterly different. Rebo (Junior) is embedded in practice at a training workshop with set tasks and the same equipment, rooms and trainers for all apprentices. Rebo at Work is embedded in ongoing practice at different companies, each with their own

apprenticeship supervisors varying places of work, sound levels and distances to a room with a computer. We showed how our agents, despite their large overlap in design strategies, have to be viewed as distinct socio-technical systems.

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