

Rebo at Work

Reflecting on Working, Learning, and Learning Goals with the Reflection Guidance Chatbot for
Apprentices

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ABSTRACT

In Rebo at Work, chatbot Rebo helps apprentices to reflect on a work experience and associate it with their training’s learning objectives. Rebo poses questions that motivate the apprentice to look at a work experience from different angles, pondering how it went, the problems they encountered, what they learned from it, and what they take away for the future. We present preliminary results of a 9-month field study (analysis of 90 interactions of the first 6 months) with 51 apprentices in the fields of metal technology, mechatronics, and electrical engineering. During reflection with Rebo at Work, 98% of apprentices were able to identify their work experience as a learning opportunity and reflect on that, and 83% successfully connected it with a learning objective. This shows that self-monitoring of learning objectives and reflection on work tasks can be guided by a conversational agent and motivates further research in this area.

CCS CONCEPTS

• **Applied computing** → Education; • **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI; Human computer interaction (HCI); Interactive systems and tools.

KEYWORDS

Reflective learning, reflection guidance, chatbot, learning goals widget, apprentices

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1 INTRODUCTION

We describe and investigate a chatbot for reflection embedded in an online tool that supports apprentices to reflect on their ongoing work practice as training and learning experiences, and how it relates to their professions’ learning objectives. The underlying situation is familiar to most of us. As our work life or private life unfolds, best practice suggests to regularly think about how our actions relate and contribute to goals that we must meet or want to meet. Can a conversational agent support such self-monitoring? From a computational and interaction perspective, this is challenging because the conversational agent needs to be able to lead from the description of a work task to a range of pre-defined goals. At the same time, it guides the apprentice to take multiple aspects into account when reflecting on the learning opportunity at hand. Designing for reflection has been suggested to be a reference task in the fields of technology-enhanced learning and human-computer interaction (HCI) [13]. Amongst the various techniques for technologies supporting reflection [9, 21] are triggering or nudging [1, 8, 15, 31, 35, 38], collecting relevant data and presenting them to cue individual or shared reflection [8, 19], and structuring the reflection process itself [22, 37, 42, 43]. Structuring the reflection process by guiding users with the help of conversational agents is a more recent but increasingly popular approach [e. g. 18, 20, 42, 43]. There are chatbots that guide users to reflect on self-set goals [18–20], and there are chatbots for reflection on set learning tasks [41–43]. A chatbot that relates a learner’s self-picked work task to a set of given learning objectives, can help the learner to associate a fitting one and guide them to reflect on the whole learning opportunity, is new.

We build on prior work [41–43], where we developed a chatbot that guides apprentices to reflect on practical learning tasks set by supervisors in the context of their training at a dedicated training workshop. In contrast, we set the here presented learning intervention in the context of apprentices’ everyday work at their respective training companies. This embedding of reflection in ongoing practice has been investigated for reflection prompts [1, 8, 18, 20, 35] but not yet for conversational agents. We want to assist apprentices to build bridges from work practices to integrated knowledge, turning their experiences into knowledge through reflection [cf. 34].

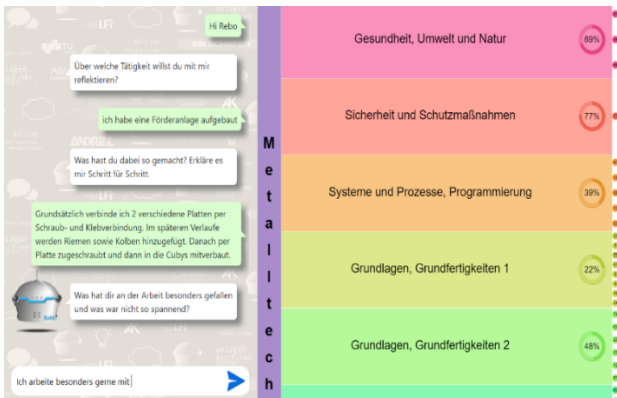


Figure 1: Rebo at Work online tool - Chat with Rebo & Learning goals rainbow widget

In this paper we describe the development of the online tool for apprentices *Rebo at Work*, featuring Rebo, the reflection guidance chatbot, and a rainbow widget with the apprentices' learning objectives (Figure 1). In this preliminary evaluation, we include selected data from the first six months of an ongoing 9-month-field study, namely 90 reflective interactions of 51 apprentices in metal technology - mechanical engineering, mechatronics - automation technology, and electrical engineering - systems and industrial engineering.

2 MOTIVATION

Reflective learning is an individual, meta-cognitive process where a learner critically reviews an experience with the goal to learn from it [cf. 2, 5, 33]. The reflection object is defined by what is reflected on and improved by the reflection process [26]; in our case, the apprentice's work practice. The apprentice who is guided to reflect actively picks a work task they attribute importance to and reflects on this learning opportunity with the goal to improve this same practice. It is important for apprentices to be able to reflect and learn in a self-regulated manner [34] in order to adapt to ever changing work environments as they proceed in their careers. Self-regulated learning means that learners themselves set directions and provide substantial impulses for learning [39]. In various theories on self-regulated learning [27], reflection plays a key part [14, 28, 44]. Especially Pintrich [28] and Zimmerman [44] explicitly declare reflection as core process for all self-regulated learning. With the ever growing importance of lifelong professional learning [19], self-regulated learning in various settings has sparked associated research in schools [6], higher education, [16], informal learning in workplaces [36], and apprenticeship training [4].

Supporting apprentices to reflect is also in their employer's best interest. Understanding how apprentices learn [10, 12] and creating expansive working environments enables individual as well as organizational learning [11]. It is not only important for individual learners to be competent in reflection, but also for organizations and society as a whole to have members that are competent in reflection [3, 11, 30]. Organizations profit from self-regulated, motivated workers and a positive working and learning environment.

As apprentices grow into their community of practice [cf. 25], they learn in the intersection of structured, formal learning settings at vocational school and informal workplace settings on the job¹. By guiding apprentices to reflect on their working and learning, we aim to improve their learning [cf. 4] and self-regulated learning skills and thereby contribute to bottom-up organizational learning [17, 29] in their respective companies.

3 RESEARCH QUESTIONS

The research questions we want to answer in this late-breaking work are as follows:

RQ1: How do apprentices interact with Rebo at Work? – *picking a fitting work task; identification of task as learning opportunity & verbalization of the reflection process; picking a learning objective they think relates to it*

RQ2: How do apprentices reflect with Rebo at Work? – *Qualitative evaluation of reflection dialogues*

4 REBO AT WORK

4.1 Socio-technical embedding

In designing Rebo at Work, we put a major focus on embedding the learning intervention into the apprentices' professional, social, and technical environment. We considered their education structure (e.g. complementary to the steps of the apprenticeship training), different company work structures (e.g. social life, typical routines, infrastructure), specific requirements of the user group (e.g. wording and visual design) [cf.7], as well as available IT tools and systems. The system was optimized for the devices apprentices in our cohort have access to at work (laptop or desktop computers) and the online tool is accessible with a link out of their e-learning systems. Building on previously gained knowledge [41–43], a close collaboration with apprenticeship trainers from the participating companies was upheld throughout the whole process, and apprentices as well as trainers were significantly involved in the tool's development and evaluation. An overview of all collaborative and evaluative activities is given in Figure 2.

Apprenticeship supervisors were crucial for the categorization of the newly formulated learning objectives (see 4.2), as well as for associating said objectives with work descriptions in order to build up the agent's database (see 4.3). The wording for the conversational agents was also revised with three different apprenticeship trainers, making it easy to understand, familiar, and age-appropriate for apprentices and tailored to their context. In addition, interviews with all trainers were conducted, in which they were asked about their apprentices' daily activities, company setup, and how the chatbot would have to be designed and used to generate value for both the company and the apprentices. During development of the conversational agent, we informally asked apprentices for feedback on wording and meaningfulness on two points in time. Two months before roll-out, we tested a prototype of the tool with 11 apprentices from one of the partner companies and asked them for open feedback.

¹Apprenticeship training in Austria (similar to Germany and Switzerland) is a form of dual education over the duration of two to four years. The apprentice works in a company with the guidance of a supervisor and in parallel attends part-time vocational school [24].

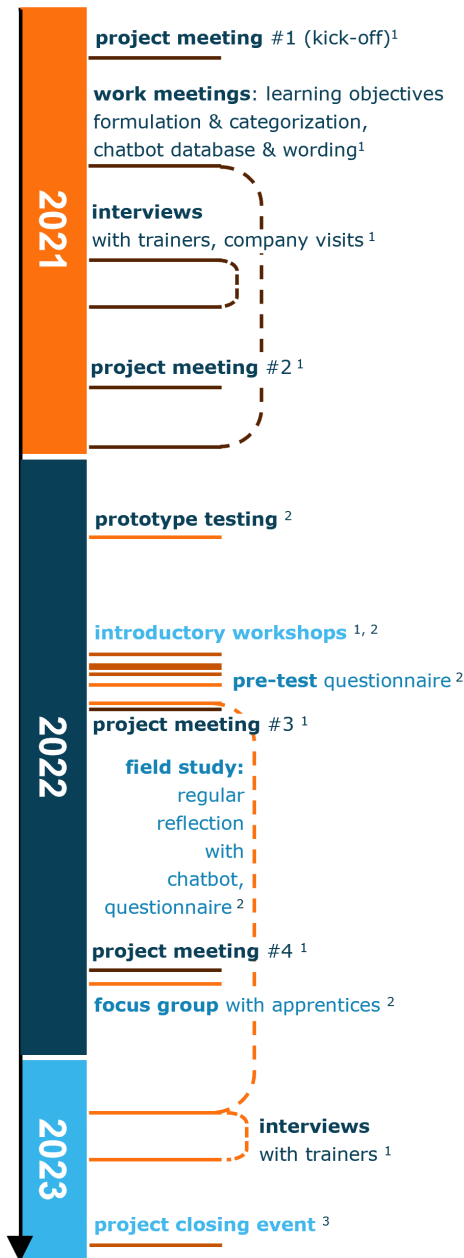


Figure 2: Timeline of collaborative and evaluative activities with apprenticeship trainers and apprentices. ¹ Activities with trainers, ² Activities with apprentices, ³ Activities with both trainers and apprentice

4.2 Learning Objectives and the Learning Goals Rainbow Widget

Competencies and skills required from Austrian apprentices in their final examinations are defined in official training regulations based on the Vocational Training Act [32]. The formulations of these competencies and skills vary from rather brief descriptions, such

as “Knowing the content and goal of the training (electrical engineering)” to concrete and measurable learning objectives. These include an action part describing what an apprentice should be able to do, as well as a content part describing the object of the action, for example “The expert can explain the basics of apprenticeship training (examples) (metal engineering)”. For Rebo at Work, we reformulated the descriptions of competencies and skills for three professions (metal technology - mechanical engineering, mechatronics - automation technology, electrical engineering - systems and industrial engineering) according to the learning objective approach, but instead of using the starting phrase “The expert” we wrote the learning objectives in first person to make them more relatable, e.g., “I can explain the basics of apprenticeship training (examples)”. To ensure that the learning objectives are meaningful and suitable for the apprentices, we collaborated with two apprenticeship training managers of two participating companies on i) the formulation of the learning objectives and ii) development of a system for clustering the learning objectives into practice- and workplace-relevant groups (see timeline, Figure 2).

The clusters and the learning objectives assigned to the clusters were then visualized in the system using a structured visualization we call the “Learning Goals Rainbow Widget” (see also Figure 1). The widget provides apprentices with an overview of the learning objectives of their respective professions with the possibility to quickly self-assess their skill level with a slider (indicating 0-100%). This is meant to encourage them to reflect on the overall journey of their apprenticeship and professional career, and on their personal progress concerning their training goals.

4.3 Rebo, the Reflection Guidance Chatbot

The conversational agent for Rebo at Work was built on prior versions of the chatbot Rebo. It was first designed as conversation script leading through subsequent aspects of reflection. We first evaluated the script regarding reflectivity and coherence of resulting dialogues [43], and subsequently investigated apprentices’ improvement of reflection skills after a 3-month-field study with repeated chatbot interactions [42]. The structure was then matured into a conversational agent [41] and has been further extended for Rebo at Work (example interaction, see Figure 3).

Rebo guides apprentices to reflect on a work experience, prompting them to reflect on multiple aspects of the learning experience. Rebo’s previously evaluated dialogue structure includes the reflection aspects description (of work experience), emotions (experienced while working), judgement (of outcome), learning (framing as learning opportunity), and planning (intended behavior change). For Rebo at Work, we have expanded the dialogue structure as follows:

The work task to reflect on (revisit) is not picked by trainers, apprentices themselves determine which learning experience of the last two weeks was interesting for them and relevant to their education and training.

1. Rebo asks if the apprentice encountered problems during their work. If this was the case, Rebo guides them to think who could help in this situation and to formulate a question they could pose.

2. Rebo refers to the apprentice’s learning objectives in the rainbow widget and asks them to associate one of them with their

Hi Alexis!	If you want me to give you a tip, write 'give me a tip'
hello	The learning objective is 'I can use company hardware and software'.
What work do you want to talk about today?	Please explain to me what you learned concerning this learning objective.
About the additional delivery of ILTS	I have improved my work on the computer, and I have learned a lot from that.
Please explain to me in your own words what you did, step by step.	Nice! :D
I got a list from my supervisor with ILTS, where I should add the rest of the ILTS that were missing.	You can record in your widget that we talked about this learning objective! Maybe you can move the slider a bit to the right :) When you tackle a similar task in the future, what will you do differently and what will you do the same way?
What did you really like about this job and what didn't you like?	I will do everything the same as last time
I liked all of it.	Sounds good!
It's really cool when you have fun in your job!	Which other applications does this have in the field?
If you assess yourself, school grades 1-5, how would you grade the result of your work and why?	Almost exclusively in the office. But there are also departments that work with AMS.
I because I'm doing a very good job	Thank you for discussing this with me, now we're almost done :) Okay
Nice :) No	Okay
Was there a time during your work where you didn't know what to do, or was there something you didn't understand?	I found our chat really ok, everything's on track :) Everything ok from my side too.
What did you learn from this work?	How was our talk for you?
How to do a subsequent delivery in the app AMS	Have a nice day! I look forward to our next chat :) Cheers, same here
When you have a look at the learning objectives of your job according to the training regulations, which ones did you tackle with this work? Click on one of the fitting learning objectives in the widget on the right!	

Figure 3: Translated (average) example interaction: first interaction of an apprentice with Rebo at Work

learning experience by clicking on it. If the apprentice asks for a tip, Rebo suggests up to five learning objectives fitting the apprentice's task description for them to choose one. Subsequently, the learning objective is discussed, and the apprentice encouraged to adjust the self-evaluation slider.

3. The reflection aspect "planning" was split up into "planning similar" (how a similar task would be tackled in the future) and "planning adaptation" (other potential applications of the skills learned with the task at hand).

4. At the end of the interaction, Rebo provides feedback and gives the apprentice the opportunity to comment on the interaction as well.

Some changes to the tool were implemented while the field study was ongoing, including improvements on graphic design, improved chatbot performance, and a slight simplification of the dialogue structure for more clarity.

Most adaptive turns of the agent are implemented with dictionaries. For Rebo's tip for learning objectives, we collaborated with six apprenticeship trainers of five participating companies to build up a database of work descriptions with fitting learning objectives. During the interactions, we first remove functional words (such as prepositions, pronouns) from responses to revisit and description using a stop list. Second, we perform full-text matching, calculating the percentage of mutual keywords in users' responses and our database of learning objectives and work descriptions. In case there are no matches found, we finally perform a substring matching, in order to suggest five or less fitting learning objectives. Reflectivity analytics for Rebo's feedback comment are described in our forthcoming publication [41].

5 EVALUATION IN A FIELD STUDY

We present and analyze the first part of a longitudinal field study of an ongoing research project. The full study is planned from May 2022 to January 2023, we limit this paper to analyzing log data from the initial six months (incl. October 2022). Before the start of the field study, we held introductory workshops for all apprentices. In these workshops, the apprentices were informed about the project and their participation in the field study, as well as the benefits of reflection. They were introduced to their training's learning objectives and asked to associate them with example work tasks in small groups of two to four people. In the workshops, they could try out the chatbot for the first time and give open and anonymous feedback. We held separate workshops for their trainers in order to introduce the tool and elicit expected outcomes.

Prior to their participation in the evaluative actions taken in the project, all apprentices gave their written informed consent to take part. With their consent, we collected and stored personal and descriptive data separately, before the start of the field study, to ensure a higher degree of anonymity. Apprentices were asked to reflect once each month, guided by the questions of the chatbot with the Rebo at Work online tool. We asked their trainers to ensure that each apprentice reflects at least three times with the chatbot throughout the field study, to remind their apprentices to reflect, and to offer them dedicated timeframes and infrastructure (e.g., quiet room, computer) for the reflection sessions. Apprentices also filled out a questionnaire at the beginning and end of the field study. Additionally, small group discussions with volunteer apprentices were held and trainers were interviewed. Once the field study has wrapped, we will re-evaluate and expand our research questions and include all collected data.

5.1 Research setting and study participants

For this analysis, we include the apprentices of two of the six participating companies (n=51). Due to their experiences with a previous chatbot prototype and their less regular reflection sessions, 21 apprentices from four companies were excluded from the analysis, two apprentices were excluded because they terminated their training. In this sample, 19 (37%) apprentices are training in “metal technology - mechanical engineering”, 20 (39%) are training in “mechatronics - automation technology”, and 12 (24%) are training in “electrical engineering - systems and industrial engineering”. The majority of the apprentices (90%) are male, a representative gender distribution in this field - trades and crafts apprentices are 81% male [40]. At the beginning of the field study, most apprentices (66,7%) were between 16 and 19 years old (typical for Austria). The total age range was between 15 and 32, though only 15,9% of apprentices were over 21, with 18 being the most frequent age. Finally, 29% were first-year apprentices, 28% were in year two and 43% were in year three.

5.2 Analysis

In this preliminary analysis of the field study, we focus on the regular reflections of the apprentices with Rebo at Work in their respective workplaces. For each apprentice, we include their first and third reflective dialogue with Rebo at Work (n=90, 12 apprentices did not have a third interaction at that point). To answer our research questions, the 90 reflective dialogues were analyzed applying Kuckartz’s content structuring qualitative content analysis [23]. A coding system was developed by initial inductive coding in the project team, which was then used to deductively code the rest of the reflections. The coding system consists of six categories with several subcategories each. For every subcategory we added a coding guideline and code example to ensure transparency and reliability.

6 PRELIMINARY RESULTS

6.1 RQ1 - How do apprentices interact with Rebo at Work?

Reflection object specified: In 59 of 90 interactions (66%), apprentices chose finished, job-specific tasks to reflect on. In six interactions, apprentices reflected on finished tasks that are specific to apprenticeship training but not to their chosen profession in particular. Nine apprentices (10%) started their reflection with a wider topic relevant to their training and narrowed it in as they carried on interacting with Rebo. Six apprentices reflected on work tasks that are not finished yet, and four apprentices reflected on courses they completed as part of their training. Two interactions were initiated by the apprentice defining a certain timeframe (such as last week) as the topic of their reflection and the actual working and learning experience was verbalized later in the interaction with Rebo. Another four apprentices picked a learning objective to reflect on, which was not intended by the tool but worked out as insightful reflection, nevertheless.

Identification of work as learning opportunity and verbalization of the reflection process: In 88 interactions (98%), the apprentice was able to identify the work experience as a learning opportunity and

elaborated on it. We define the identification as learning opportunity by the presence of the reflection aspects learning or planning (c.f. [42]) in the interaction. 69 apprentices (77%) were even able to identify possible adaptation of what they learned to other contexts in their work or personal lives.

Picking a learning objective corresponding with the learning experience: In 75 of 90 interactions (83%) a learning goal was associated with the learning experience triggered by the reflection object the apprentice had specified. In 46 (51%) of these, the apprentice picked a learning objective on their own; in 29 interactions (32%) the apprentice asked Rebo for help and then picked a learning objective based on Rebo’s suggestions. There are nine interactions (10%) where apprentices asked Rebo for a tip but then did not choose a learning objective. A closer look at these reveals that only one apprentice found Rebo’s suggested learning objectives not fitting to their reflection object (seven reflected on one or more learning objectives but did not click and send it in the chat, and one apprentices had technical issues). For an example interaction, see Figure 3.

6.2 RQ2 - How do apprentices reflect with Rebo at Work?

When apprentices reflected on their learning, they mostly identified learning effects concerning their behavior and manner of working, practical competences, and knowledge. Manner of working was reflected on in 52 interactions (58%, 73 codes) and included insights on planning and management, communication, precision, and a neat workstation. Apprentices pointed out in 20 interactions with Rebo (22%) that they could work independently. Being able to work self-regulated for a while was set in the context of pride “I worked goal-oriented and independently” and enjoyment “I liked it a lot because I could do many new things and I did them on my own”. In 47 interactions (52%, 70 codes), apprentices talked about improvement of practical skills and identified learning based on the work process. For example, Rebo: „What did you learn from this task?“, apprentice: “How to use a milling machine”. In 23 interactions (26%, 35 codes), reflection on work tasks lead to theoretical insights and knowledge construction, such as how various machines work, how materials react, and health and safety regulations (e.g., “how different motors work and when they are used”). Four apprentices (4%) claimed to have learned nothing from the work task they reflected on. A closer look at these interactions reveals that in one of them, learning was identified in another part of the interaction and in two of them, Rebo’s follow-up question on the learning aspect triggered insights. They had not picked up new practical skills but when asked a second time, they verbalized more general insights.

As part of the reflection process, we identified analytic reflection, emotional reflection, and self-reflection. On 112 occasions in 67 interactions (74%), apprentices analyzed the learning experience in their reflections. These analytical thoughts happened on all stages of the dialogue, most of them were triggered by Rebo’s questions concerning the reflection aspects learning and planning. For example, Rebo: “What would you say you’ve learned from this work?” Apprentice: “How to solve problems.” Rebo: “I need some more information :)“ Apprentice: „I learned how to help myself and find my way out of confusing situations“. Mostly triggered by Rebo’s

questions on the aspect of attending to emotions and judgement, apprentices reflected on which aspects of their work give them joy and what they feel less enthusiastic about. We coded 84 occasions in 74 interactions (82%) where apprentices expressed their emotions concerning their work and learning (e.g., “I really liked connecting the cable but drilling into the steel beam was exhausting”). In 13 interactions (14%), apprentices reflected on how interesting the task at hand was for them (e.g., “I just find it really interesting how the machine works”). We further coded 18 occasions of self-reflection where apprentices wrote about how they are improving (e.g., “I don’t like how repetitive this work is, but I’m getting faster all the time”).

We also investigated intention for future behavior change, and in 32 interactions (36%), apprentices stated that they were not planning on doing anything differently when faced with a similar task again. In nine interactions, apprentices specifically mentioned that the manner of work is fixed, that there is no room for different approaches and that the task at hand was repetitive. This does not mean that they cannot think of future applications for the acquired skills, the planning adaptation aspect was reflected on, and future application possibilities were found just the same. If the job is well done and properly executed, it makes sense that there is no planning similar aspect to reflect on for them. We interpret this as argument for “planning similar” and “planning adaptation” being utterly different reflection aspects, and for attending to them separately in the agent’s dialogue structure.

Additional to our research questions, we found that technical problems were demotivating when at the beginning of the field study, network interruptions led to interrupted conversations. We adapted the agent, so that Rebo picked up the last interaction where it had ended to enable apprentices to finish their guided reflections straight away. Before that Rebo had started a new interaction which led to frustration. Another technical problem we had was Rebo sending two messages at once without waiting for an answer first. This led to temporary coherence problems. They were, however, not permanent. When Rebo moved on to the next phase of the interaction (reflection aspect/new branch) coherence was re-established. We attribute this to the solid dialogue structure and cooperation on part of the users to engage with Rebo’s next question.

7 DISCUSSION AND OUTLOOK

We take from this study that forging a bridge from work experience to personal learning insights to official learning objectives with the help of a conversational agent is possible and works with apprentices. Guided by the chatbot, apprentices in our cohort were able to pick a work experience, interpret it as a learning experience and reflect on it. We further saw that Rebo’s assistance in matching a fitting learning objective was used and worked well. Apprentice’s interactions with Rebo resulted in broadly ranged, personal and individual reflections. We observed our apprentices reflecting on learning insights concerning various aspects of their training. They verbalized analysis of the learning experience, emotional reflection, and self-reflection in the process.

We look forward to a full evaluation of the 9-month-field study. The same analysis that we report here for part of the log data will be done on the full data. Based on these preliminary results, we will pay

special attention to changes of reflection strategies and engagement with Rebo over time. Further insights could be gained by coding the interactions in collaboration with an apprenticeship trainer, especially to assess how well the learning objectives actually fit the tasks at hand. In addition, we will analyze both questionnaires, the focus groups with apprentices, and the interviews. This should yield further insights on acceptance and usability of the tool, as well as changes of apprentices’ self-regulated learning skills over the duration of the study. An interesting feature that emerged was that when chatting with Rebo, apprentices mostly provided positive feedback on the interaction, but in communication with us, they complained about problems. It seems as if the chatbot is personalized in the sense that they communicate with Rebo in a face-saving manner. We look forward to exploring this phenomenon further. Connections of our insights to other research in the CHI community on repeated long-term chatbot interaction, and on how learners interact with conversational agents should be explored further.

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