Please quote as: Elshan, Edona & Ebel, Philipp: Let's Team Up: Designing Conversational Agents as Teammates. 2020. - International Conference on Information Systems (ICIS). - Online / Hyderabad, India.

Dec 14th, 12:00 AM

Let's Team Up: Designing Conversational Agents as Teammates

Edona Elshan
Institute of Information Management, edona.elshan@unisg.ch

Philipp Ebel
University of St. Gallen, philipp.ebel@unisg.ch

Let's Team Up: Designing Conversational Agents as Teammates

Short Paper

Edona Elshan
University of St.Gallen
Müller-Friedbergstrasse 8
CH-9000 St. Gallen
edona.elshan@unisg.ch

Philipp Ebel
University of St.Gallen
Müller-Friedbergstrasse 8
CH-9000 St. Gallen
philipp.ebel@unisg.ch

Abstract

The success of projects is, amongst others, highly depended on the team members skillset and ability to collaborate. Hence, education has to undergo a change to keep up with the shift in the compositions of skills and knowledge needed for students. To overcome scalability issues, we propose to develop Timmy - a conversational agents (CAs) that acts as a team member. As there is a lack of concrete design knowledge concerning CAs as peers in teams, we conduct a design science research project. Based on requirements from scientific literature and expert interviews, we develop a concise set of design principles for designing CAs in peer roles in educational settings. Furthermore, we present an initial proof of concept evaluation. These insights will support researchers and practitioners to understand better how CAs can be systematically built to ameliorate the collaborative skill of students in teamwork settings.

Keywords: conversational agents, teammates, design science research

Introduction

Collaboration has been named one of the most relevant skills in the 21st century (OECD 2018; World Economic Forum 2016). As work is increasingly executed by teams of people with unique skill sets and roles that complement each other (Decuyper et al. 2010; Dede 2010; Edmondson 2013), the importance of collaborative capacities is growing. Further collaboration has recently gained attention in the theoretical and technological development in the field of education and design research (OECD 2017). This increased interest is not by any chance. In this respect, university education is an essential context in which these skills should be acquired (Vangrieken et al. 2015). Fadel et al. (2015) state that the skills required of students alter increasingly to higher-order thinking skills such as problem-solving, critical thinking or collaboration. At the same time, we observe that the capabilities of intelligent systems (IS) are growing at an impressive rate. However, we can also observe that the user's cognitive capabilities are not increasing at the same pace (Brynjolfsson and McAfee 2014; Maedche et al. 2016). Therefore, it is essential to equip current students and i.e. future workforce with the adequate skill set and improve their cognitive capabilities in order to close the stated gap.

A possible solution to narrow the gap might be the employment of an adaptive technology-based application in a student's learning environment. Nowadays, conversational agents (CAs) are omnipresent and have been implemented in various application domains, such as e-commerce (e.g., Pricilla et al. 2018), education (e.g., Wambsganss et al. 2020), healthcare (e.g., Falala-Séchet et al. 2019). This widespread adoption of CAs brings not only new possibilities but also challenges for research and practice in the field of human-

computer interaction (HCI) (Følstad and Brandtzæg 2017). For this reason, research is intensively engaged in the design and impact of CAs on our everyday lives.

Today, insights on how user interaction in encounters with CAs as teammates is scarce. Most of the research on CAs deals with dyadic communication and collaboration, i.e., the interaction between a single user and the CA. Nevertheless, CAs could be capable of communicating and collaborating beyond that (Seering et al. 2019). The technological advancements in Natural Language Processing (NLP), Natural Language Understanding (NLU), and Machine Learning (ML) pave the way for CAs to collaborate with humans in teams, to ask and answer questions in natural conversation flows, and use intelligent question answering to adapt to a certain task (Seeber et al. 2018). Nonetheless, Poser and Bittner (2020) observed that currently, none of the CAs is fully able to engage as a teammate and provide the support associated with the teamwork. Although prior work studied different outcomes (e.g., task performance) in relation to the deployment of CAs in a group, most of the CAs were not designed specifically to interact with multiple users simultaneously. In addition, the CA design differs completely depending on the numbers of users (e.g., one on one CA-user interaction vs. interactions within groups), social dynamics (e.g., in a crowd) as well as particular interest (e.g., within a team) (Bittner et al. 2019).

We thereby follow the call of Seering et al. (2019), Seeber et al. (2020) as well as Poser and Bittner (2020) and consequently address the following research question:

RQ: *What are the design principles that should be considered when designing a conversational agent that acts as a teammate in an educational context?*

To answer this research question, the remainder of this paper is structured as follows. In the next section, we define and describe conversational agents in the theoretical background. Afterwards, we describe the research methodology and how we followed the design science research process (DSR) to design the CAs as a team member (artefact). Next, we will discuss the results so far and close with our next steps and the contribution of our project.

Theoretical Background

Conversational Agents and Teamwork

We understand conversational agents in the context of this study as Artificial Intelligence (AI)-based computer programs that assist customers by interacting via natural language in the form of text-based communication (Pfeuffer et al. 2019). New emerging CAs have the aptitude to provide feedback on their motion, offer recommendations and track the involvement of a group in teamwork as well as the individual contributions of the team members (Graesser et al. 2017). Some studies have indicated that this rising class of IS can collaborate among multiple users in rather complex settings (Winkler et al. 2019). Following the definition of Seeber et al. (2018), Bittner et al. (2019), and Seeber et al. (2020), CAs can be described as intelligent autonomous machines, which are capable of associating itself with human team members.

In prior research, CAs took different roles: (1) *Expert*, (2) *Facilitator,* and (3) *Peer* (Bittner et al. 2019). While *Facilitators* behave mostly proactively and guide the user to the collaborating goal, *Peers* show socio-emotional behavior to become a part of the group without dominating the conversation. When acting as *Experts,* they exhibit skills that complement the users' skillset and behave reactively upon requests.

In accordance to Cohen and Bailey (1997, p. 241), "*A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or larger social systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries*". In this vein, we will only refer to the role of the CA as *Peers* and will focus our attention on this setting of human-computer interaction.

Social Response Theory as Kernel Theory

The social response theory serves as a Kernel Theory in our research endeavor. This theory suggests that individuals treat computers as social actors (CASA paradigm) (Nass et al. 1994; Nass and Moon 2000). Further, they propose that individuals treat computers with social cues as social actors and would, therefore, apply similar patterns and heuristics of human to human interaction to human to computer interaction (Nass and Moon 2000). In the past researchers have suggested that CAs need to adopt the

characteristics of social interactions with individuals to become more engaging (Derrick et al. 2011; Elkins et al. 2012). Prior researchers studied the users' reaction to anthropomorphic characteristics of CAs (Krämer et al. 2015) and how such cues affect the behavior of individuals, e.g. language style or response time (Gnewuch et al. 2018; Lee and Choi 2017). Although longitudinal studies on the relationship-building with embodied CAs (e.g., expression of facial expression) show promising results (Bickmore et al. 2010), they often cannot be adapted and implemented into other application areas.

Further, they are frequently designed to interact with one single user and not multiples at the same time. According to Bittner et al. (2019), the design of the CA varies with the numbers of users. Therefore, the prior findings are not easily transferable to CAs designed for collaboration and interaction as a teammate. Hence, we argue that the social response theory might explain why CAs might be able to act as teammates, which might lead to a better task performance of student's group interaction.

Research Methodology

In order to answer our research question, we follow the Design Science Research (DSR) approach. We chose this approach because we wanted to a) contribute to the existing body of knowledge by designing and evaluating a new research artefact and documenting our design knowledge according to Gregor and Jones (2007) and b) use a scientific method to solve a set of practical problems that researchers and practitioners experience in their practice. In specific, we rely on Hevner's three cycle view to structure the research process (Hevner 2007). Figure 1 shows the steps that have been carried out as well as their order and the corresponding sections within this paper.

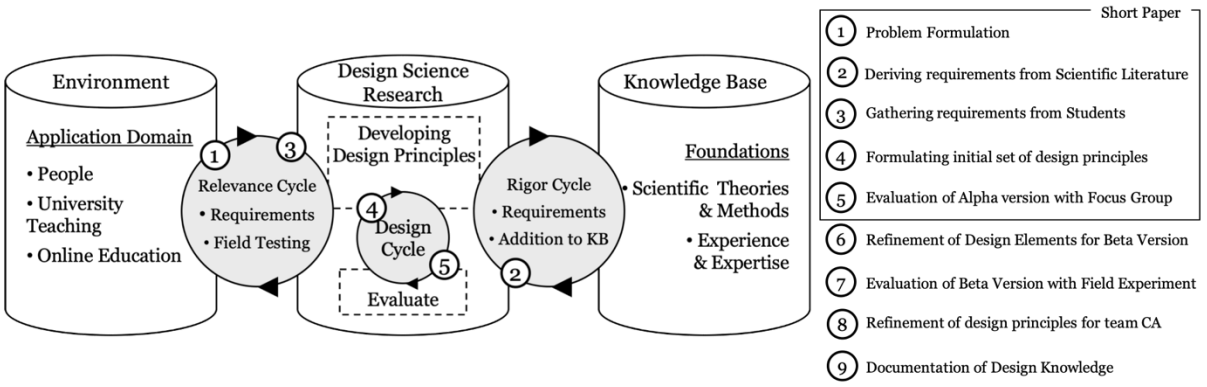

Figure 1. Our DSR Process

The first step includes the problem formulation. The practical, driven motivation of the problem was discussed in detail in the introduction section. In the second step, we initiate the rigor cycle, where we gather requirements from different theoretical perspectives. In the third step, we initiate the relevance cycle by deriving requirements from student interviews. In the fourth step, we initiate the design cycle by formulating the initial set of design principles for CAs as teammates. In the fifth step, we conduct the first evaluation of our alpha version with the help of a focus group discussion. The reason for this evaluation is the assurance that we capture the essential requirements and logically translate them into design principles (Sonnenberg and vom Brocke 2012). Step 6-9 will be out of the scope of this short paper and will be the subject of following research.

Designing Conversational Agents as Teammates

Based on the problem formulation (Step 1) in the introduction, this section will discuss how we derived the (meta-) requirements as well as the design principles that are important for the development of the CA as a team member. Figure 2 summarizes the insights we gathered during this process.

Step 2: Deriving Meta-Requirements from Scientific Literature

The initiation of the rigor cycle is the deriving of requirements from theory. We conducted a systematic literature review following the approaches from (Vom Brocke et al. 2015) and (Webster and Watson 2002) as well as (Cooper 1988). In accordance with these established methodical approaches, we initially defined the review scope. In the next steps, we conceptualized the topic and searched the literature. Finally, we analyzed the findings and derived requirements. In order to define the scope, we set our focus on research outcomes, applications, and theories that demonstrate the deployment of CAs in collaborative settings. Further, we focused on identifying requirements to espouse a position (Cooper 1988). Regarding the conceptualization of the topic, we chose to address general scholars. Following up, we selected domain-relevant databases ("ACM Digital Library", "IEEE Xplore", "EBSCOhost Business Source Complete", "AIS Electronic Library" and "Science Direct") to conduct a keyword search with the following exemplary search string: *("conversational agent" OR "smart personal assistant" OR "chatbot") AND ("team*" OR "teamwork" OR "collabor*" OR "coop*")*

After two screening phases, we selected 36 papers. In the first screening phase, we excluded duplicates as well as irrelevant publications by reviewing titles and abstracts according to our criteria for inclusion and exclusion. We only included papers that address some kind of collaboration and the use of conversational agents in order to derive requirements successfully. We excluded papers that focused, for example, on service encounters because they addressed a different research area of CAs. In the next step, the identified literature was analyzed and synthesized. Ultimately, similar findings were clustered following Poser and Bittner (2020) to derive meta-requirements from theory. These clusters and requirements from theory are depicted in Figure 2.

The first requirement derived from theory (RT1) raises the importance of the alignment of shared objectives and understandings to enhance teamwork. Prior literature mentions the importance of shared mental models for group performance (e.g., Winkler et al. 2019). The second requirement from theory (RT2) deals with the need for active guidance as well as delegation. As literature shows, there exists a need for CAs to coordinate actions with students to unlock potential knowledge and capacities efficiently (e.g., Lopez et al. 2014; Meo et al. 2019). Furthermore, previous work has pointed out the relevance of the relationship-building (e.g., Azevedo et al. 2017; Kowatsch et al. 2018; Nass and Moon 2000). Therefore, the third requirement from theory deals with the social orientation of the CA as well as the engagement and involvement in off-task conversation. The fourth requirement from theory (RT4) expresses the need for the CA to act proactively (e.g., Falala-Séchet et al. 2019; Ruan et al. 2019). Consequently, the conversation should neither only be led by the user nor only the CA but should be established proactively by all included parties (e.g., Tegos et al. 2015).

Step 3: Gathering Requirements from Students

The application domain education involves students from different levels and teaching formats (high school, university, online education). In the first instance, we wanted to gain a better understanding of the current problem students face in collaborative settings (e.g., teamwork) and what they think of working with a CA to enrich collaborative settings. Thereby, we conducted fourteen interviews with students from high schools and universities. The student interviewees were chosen out of a random subset of the population of students at our university (undergraduates and graduates majoring in business studies; participants of a business innovation course) as well as a Swiss high school (majoring in engineering and business; students who are coached by one of the authors in a group project). Eight students were male and six were female, all aged between 18 and 27.

All the interviews were semi-structured and were conducted according to Gläser and Laudel (2010).In the first part of the interview, we asked students to recall the last time they have worked in a team and to mention all the things they liked and disliked. In the second part, we presented the idea of CA as teammates. Based on that, we asked them about possible requirements for the new team member. Each interview lasted

from 10 to 25 minutes. We transcribed the interviews and analyzed them using the method of user stories proposed by (Cohn 2004). User stories are part of an agile approach that helps shift the focus from writing about requirements to talking about them. Based on an abductive and iterative approach, we coded each interview to create an initial list of user needs. In a subsequent step, we grouped similar topics arising in the interviews as user stories (US) and formed nine clusters from them (see Table 1).

Table 1. User Stories and Requirements from Students

User Stories	Requirements from Practice (RP)
US$_1$: As a *student*, I would like to work with a CA that is goal-oriented so that we reach our goal.	**RP$_1$**: The CA should actively assess the group process and set milestones.
US$_2$: As a *student*, I would like the CA to communicate formally but in a familiar style.	**RP$_2$**: The CA should articulate itself in a professional and at eye-level.
US$_3$: As a *student*, I would like to collaborate with a CA that is a team player and not an egoist.	**RP$_3$**: The CA should be empathetic and responsive to the needs of team members.
US$_4$: As a *student*, I would like to work with a CA that provides another skill set that I have so that we can complement each other.	**RP$_4$**: The CA should be able to adapt to the needs of the team and different tasks.
US$_5$: As a *student*, I would like the CA to reply fast and give me feedback when I need it so that I can reassess myself.	**RP$_5$**: The CA should process the student's input and provide the student with prompt, precise, and objective feedback.
US$_6$: As a *student*, I would like to put almost no effort into meeting the CA and use it anywhere and anytime (e.g., Apple's Siri on iPhone or MacBook).	**RP$_6$**: The CA should be available anytime and accessible via different devices.
US$_7$: As a *student*, I would like the CA to be persistent and keen on details so that we achieve the maximum from the teamwork.	**RP$_7$**: The CA should keep an overview and compare the status quo with the desired target.
US$_8$: As a *student*, I would like to work with a CA that shares my mind so that no conflicts arise.	**RP$_8$**: The CA should include social cues that trigger human-like behavior.
US$_9$: As a *student*, I would like to collaborate with a CA that shares the load (equity and fairness) so that nobody is left feeling disadvantaged.	**RP$_9$**: The CA should have a sense of fairness.

Step 4: Deriving Design Principles for the Alpha Version

We formulated an initial set of four preliminary design principles, based on our findings of the previous two steps, according to Gregor et al. (2020). As illustrated, we have identified four requirements from theory, nine user stories and formulated four preliminary meta requirements and nine preliminary requirements from practice. The design principles are depicted in Figure 2. Moreover, to provide an instantiation example of our design principles, we designed an initial version to give guidance and illustration for scientists and practitioners (Figure 3).

The first design principle (**DP1**) specifies that the CA should provide the students with elaborated feedback. New emergent CAs have the capabilities to provide valuable feedback when interacting in a natural conversation flow with users. During the interviews, multiple students stated that it is very frustrating to work together with someone that does not provide them with feedback. Further, it was mentioned that they appreciate when the current process is assessed and adjusted to the target.

The second design principle (**DP2**) takes the shared understanding and building of the common ground into consideration. The shared understanding, respectively, shared vision has an essential function; it distinguishes teams from individuals or groups (Salas et al. 2000). In addition to that, Klein et al. (2004) state that CAs should be able to share a mutual understanding by sharing information with their teammates, which is consistent with their shared mental model (Mathieu et al. 2017). The *humanness* and *social presence* (**DP3**) relate to how the CA is represented and how it interacts with the human teammates. This is in accordance with the social response theory, which proposed that individuals, in our case students, treat computers with social cues as social actors (Nass et al. 1994; Nass and Moon 2000).

Further, humans would employ norms as well as rules used in human to human interaction when interacting with computers. The fourth design principle (**DP4**) defines that the CA should be a web-based application in order to be available for students from anywhere at any time independent of the operating system in use. Today's students frequently use web-based application and expect to access the CA at any time and any place. To meet this requirement, we suggest employing the CA as a web-based application that can be easily accessed via a browser. In addition, this allows for quick response time.

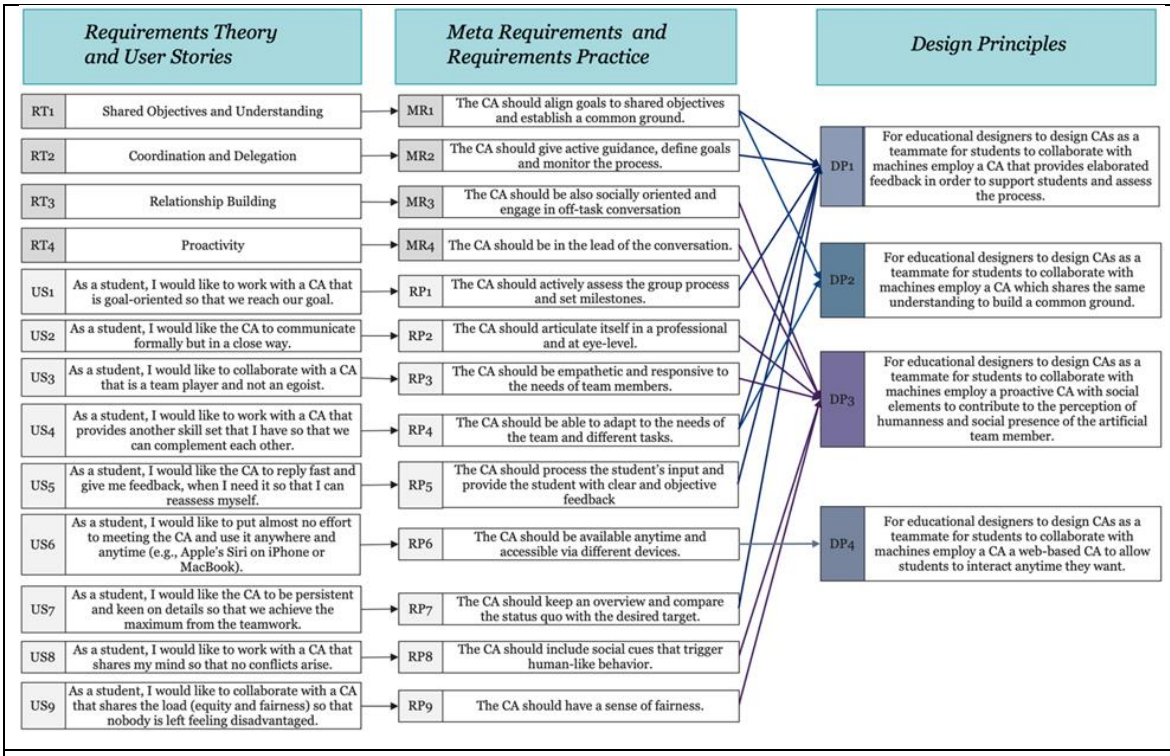

Figure 2. Overview of the Design Principles derived according to Gregor et al. (2020)

Step 5: Evaluation of Alpha Version

Sonnenberg and vom Brocke (2012) stated that it is essential to direct the foci of evaluations on two aspects: (1) the constituents of the artefact and the design decisions take as well as on (2) the evaluation of the usefulness of the artefact. Thereby we evaluated the alpha version of our artefact using an artificial evaluation setup (Venable et al. 2012). With the help of a focus group discussion, we verified the validity of our derived requirements and checked the completeness of the design principles. According to Sonnenberg and vom Brocke (2012), a suitable method of evaluating design within DSR projects are focus group discussions. The focus group discussion was conducted with 5 participants and lasted 50 minutes. The participants were master students majoring in business studies. One of the researchers acted as a facilitator and introduced the aim of the discussion. Moreover, we showed the participants our requirements and an expository instantiation of the design principles and asked them to review them based on the criteria a) logic, b) usability, and c) usefulness.

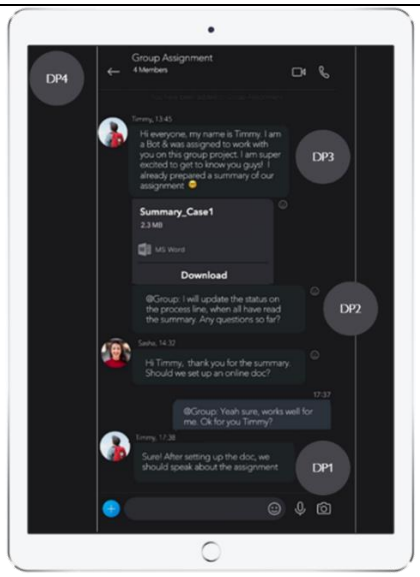

Figure 3. An Expository Instantiation

In general, the derived requirements were considered logical and useful. Nevertheless, we were able to collect further design principles. Based on the insights, we propose the fifth and the sixth design principle. The fifth design principle should include the communication mode of the CA. The student reported that they would like to talk rather than chat with a CA. The communication via voice is perceived as more natural when working on a project together with other teammates. Besides, they stated that misunderstandings, which can arise via text, would be avoided by discussing the subject via voice. We will include this as a design principle and will evaluate its outcome in our next DSR cycle. The sixth design principle defines that students should, at any time, be able to assign tasks to the CA, e.g., finding relevant literature. In this way, it is intended to ensure that the CA genuinely represents a part of the team and is by no means just another tool for teamwork. In sum, we argue that these preliminary design principles may be suitable to design conversational agents as teammates. Nevertheless, the insights gained through this evaluation will start the next DSR cycle and will be the basis for our first instantiation of the CA as a teammate in a real-world setting. In the further course of our DSR project, we would like to evaluate if the collaboration skills of students may increase through the usage of the CA.

Conclusion and Next Steps

In this paper, we present the first steps of designing a conversational agent that interacts as a teammate to help students to enhance and refine their collaborative skills. Based on the analysis of 36 scientific papers and 14 semi-structured interviews with students we rigorously derived requirements and formulated a concise set of four design principles. Hence, we discussed four requirements from theory and nine user stories on how to design a conversational agent as a teammate. We presented an initial version as an expository instantiation of these design principles and evaluated that expository instantiation with the help of a focus group discussion. In a next step, we will start with the second DSR cycle and will rely on a greater number of participants for our future design iterations. In our next iteration, we will further evaluate our design principles following a technically risk and efficacy strategy (Venable et al. 2016), where we first conduct a series of laboratory experiments to establish causality and then will evaluate its usefulness in a field experiment. In this paper, we specifically focused on the CAs role as a *peer*. In our future research we will expand our scope and address the *experts* and *facilitators* role in team collaboration.

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