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DESIGN KNOWLEDGE FOR VIRTUAL LEARNING COMPANIONS

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Abstract:

Conversational agents (CAs) are getting smarter thanks to advances in artificial intelligence, which opens the potential to use them in educational contexts to support (working) students. In addition, CAs are turning toward relationship-oriented virtual companions (e.g., Replika). Synthesizing these trends, we derive the virtual learning companion (VLC), which aims to support working students in their time management and motivation. In addition, we propose design knowledge, which was developed as part of a design science research project. We derive nine design principles, 28 meta-requirements, and 33 categories of design features based on interviews with students and experts, the results of an interdisciplinary workshop, and a user test. We aim to demonstrate how to design VLCs to unfold their potential for individual student support.

Keywords: Conversational Agent, Education, Virtual Learning Companion, Design Knowledge

I. INTRODUCTION

In a fast-paced and increasingly digital work environment, lifelong learning is becoming crucial for professional success (Finster & Robra-Bissantz, 2020). Technological progress and the trend toward digital learning are creating new opportunities for professional development. However, it is esp. challenging for working students/learners in professional development to continuously motivate themselves and adequately manage their time as they face the double burden of work and study (Rodriguez, Piccoli, & Bartosiak, 2019; Wang, Jing, Camacho, Joyner, & Goel, 2020). Virtual learning companions (VLCs) represent an innovative solution approach to accompany students individually in their learning process (Grivokostopoulou, Kovas, & Perikos, 2020; Khosrawi-Rad, Schlimbach, & Robra-Bissantz, 2022; Schlimbach, Khosrawi-Rad, & Robra-Bissantz, 2022). VLCs are digital and humanoid learning facilitators that establish a friendly relationship with their users (Khosrawi-Rad, Schlimbach, et al., 2022). Although VLCs have gained attention in research, for instance, since they foster learners' motivation (e.g., Grivokostopoulou et al., 2020; Khosrawi-Rad, Rinn, et al., 2022) as well as their time management (e.g., Rodriguez et al., 2019), there is a lack of prescriptive VLC design knowledge (Khosrawi-Rad, Rinn, et al., 2022; Strohmann, Siemon, Khosrawi-Rad, & Robra-Bissantz, 2022). This paper addresses this research gap by deriving meta-requirements (MRs), design principles (DPs), and design features (DFs) for VLCs. Thereby, we aim to answer the following research question (RQ): *How to design VLCs to* *motivate working students to learn and support them regarding effective time management?* For this purpose, we conduct user interviews, a user test, a literature review, and expert interviews.

II. RESEARCH BACKGROUND

From Pedagogical Conversational Agents to Virtual Learning Companions

VLCs have their origins in so-called pedagogical conversational agents (CAs), which communicate with their users either text-based (as chatbots) or voice-based (like Siri) (Hobert & Meyer von Wolff, 2019; Winkler & Roos, 2019). They offer the advantage of being easily scalable, location-independent, and permanently available to provide individualized support to learners (Hobert & Meyer von Wolff, 2019). Pedagogical CAs in turn go back to intelligent tutoring systems which were the first approaches to supporting dialogue-based learning by conveying learning content via a virtual tutor (Atkinson, 1968; Kulik & Fletcher, 2016; Suppes & Morningstar, 1969). In contrast to this limitation to the pure tutor role, however, the application scope of pedagogical CAs is now broader (Khosrawi-Rad, Rinn, et al., 2022; Weber, Wambsganss, Rüttimann, & Söllner, 2021; Wollny et al., 2021). In addition to imparting learning content, pedagogical CAs can serve to support in time management (Gubareva & Lopes, 2020), provide emotional support to learners in a mentoring role to facilitate learning (Ranjbartabar & Richards, 2018; Wambsganss, Söllner, & Leimeister, 2020), or stimulate motivation using game elements (Benner, Schöbel, Süess, Baechle, & Janson, 2022). According to current literature reviews, the pedagogical CA research field has been gaining a lot of attention in recent years thanks to increasing technological progress (e.g., intelligent natural language processing) (Hobert & Meyer von Wolff, 2019; Khosrawi-Rad, Rinn, et al., 2022; Wollny et al., 2021). A striking example is the pedagogical CA "*Jill Watson*", which understands 97% of users' concerns, promotes social networking between students, and acts human-like to be perceived as a natural interaction partner (Wang et al., 2020). At the same time, a trend is emerging for CAs to become virtual companions that act with a long-term orientation (Nißen et al., 2021; Siemon et al., 2022; Skjuve, Følstad, Fostervold, & Brandtzaeg, 2021; Strohmann et al., 2022). Sometimes, as in the case of the CA "*Replika*", they even establish a friendship-like relationship with their users (Siemon et al., 2022; Skjuve et al., 2021; Strohmann et al., 2022). The symbiosis of these trends leads to the VLC which supports its learners individually, acts helpfully, and pursues the goal of building a trust-based relationship with them (Grivokostopoulou et al., 2020; Khosrawi-Rad, Schlimbach, et al., 2022; Schlimbach, Khosrawi-Rad, et al., 2022).

The existing pedagogical CA literature does not yet sufficiently consider the VLC approach; for instance, Khosrawi-Rad et al. (2022) identified in their literature review that out of 252 recent publications, only five refer to the term "learning companion" and two to the term "virtual companion(ship)". Furthermore, there is a lack of design knowledge for pedagogical CAs, since the authors identified only twelve publications using a DSR approach with six of them proposing DPs (e.g., Elshan & Ebel, 2020; Rodriguez et al., 2019), none of which focused on the VLC approach, which is consistent with the findings of further literature reviews (Hobert & Meyer von Wolff, 2019; Schlimbach, Rinn, Markgraf, & Robra-Bissantz, 2022).

Kernel Theories for the Design of Virtual Learning Companions

We incorporate scientifically validated kernel theories from various fields (research on human-computer interaction, education, and motivation) when designing VLCs to ensure rigor (Gregor & Hevner, 2013). First, we draw on the computers are social actors (CASA) theory, which states that humans exhibit human-like behavior toward computers by applying social norms to them (Moon, 2000; Nass, Steuer, & Tauber, 1994). CASA theory has been widely spread to explain human-like CA design (e.g., Elshan & Ebel, 2020; Feine, Gnewuch, Morana, & Maedche, 2019; Seymour, Riemer, & Kay, 2018). For instance, incorporating social cues into CAs (human-like elements such as emojis or jokes) leads to encouraging users' social behaviors and results in positive perception (Demeure, Niewiadomski, & Pelachaud, 2011; Feine et al., 2019). In addition, a human-like avatar may enable the experience of social presence, so that according to the persona effect, learning success is promoted (Lester et al., 1997). Prior research already used CASA theory to explain that considering theories of interpersonal relationships matters for CA design (Krämer, Eimler, Pütten, & Payr, 2011; Strohmann et al., 2022). For instance, this paper takes up that establishing a common ground (Clark, 1992) leads to a positive CA perception (Elshan & Ebel, 2020; Strohmann et al., 2022). Furthermore, according to the theory of interpersonal trust (Rotter, 1980), CAs should promote the building of trust by users' to be accepted in the long run (Schlimbach, Khosrawi-Rad, et al., 2022; Strohmann et al., 2022; Wambsganss, Höch, Zierau, & Söllner, 2021). To maintain motivation to learn, we rely on Csikszentmihalyi's (1975) flow theory which states that complete absorption in an activity leads to learners' engagement. In addition, learners' needs for competence, autonomy, and relatedness should be fulfilled according to self-determination theory to ensure motivation (Ryan & Deci, 2000). Facilitating interactions with the VLC through collaborative dialogue as well as other learners also helps enhance learning along with the interactive, constructive, active, and passive (ICAP) framework (Chi & Wylie, 2014; Winkler & Roos, 2019). According to the theory of multimedia learning (Mayer & Moreno, 2003), multi-media learning content is crucial to cause improved learning effects; however, cognitive overload must be avoided as well (ibid.).

III. METHODOLOGY

Design Science Research

For the derivation of design knowledge, we follow the DSR paradigm as an established approach to design new and innovative artifacts while ensuring practical relevance and scientific rigor (Hevner, March, Park, & Ram, 2004). In DSR, the process model of Kuechler & Vaishnavi (2008) is an established framework that we apply by conducting several iterative steps during artifact development.

The first design cycle covers a co-creation approach, that actively involves students from the target group in the VLC design (Abras, Maloney-Krichmar, & Preece, 2004). In the context of a 4-month course, different teams of Master's students majoring in technology-oriented management collected the learners' requirements and received close scientific guidance from us to ensure rigor, while still having the freedom to set their own priorities (Khosrawi-Rad, Schlimbach, et al., 2022). We chose this approach to facilitate participatory design (Bødker & Kyng, 2018) as well as to reduce researcher bias in artifact derivation. Thus, two independent teams of four students each conducted interviews with working students (team1 & team2) to elicit the needs and desires of potential users for the VLC before creating user stories (USs) and deriving MRs to then synthesize DPs thereupon. Another group (team3) conducted a systematic literature review to explore the status quo in needs, requirements, and design knowledge for pedagogical CAs in general as supportive literature to derive the final design knowledge (Möller, Guggenberger, & Otto, 2020). Team1 & team2 visualized their results in a mapping diagram of USs, MRs, and DPs (ibid.). Furthermore, they framed DPs according to the scheme recommended by Gregor et al. (2020, p. 1633) consisting of the components *implementer, aim, user, context, mechanisms,* and *enactors*. Subsequently, both teams elaborated an independent instantiation using the prototyping tools "*Figma*" or "*Botsociety*", respectively. To evaluate the design knowledge, team1 conducted a user test for the instantiation (*ex post evaluation*), whereas team2's theoretical design knowledge was discussed in a workshop (*ex ante evaluation*) (Venable et al. 2016).

Since the individual group results were similar in content, we combined the design knowledge in the second design cycle. To compensate for a possible research bias, the respective mapping diagrams were synthesized independently by three researchers of the author team. In particular, we adjusted the wording, summarized the content, and formulated DFs following Möller et al. (2020). We then evaluated the results again with five experts. Finally, we derived a final set of 28 MRs, nine DPs, and 33 categories of DFs.

Figure 1 illustrates the DSR procedure by mapping both DSR cycles into the framework of Kuechler & Vaishnavi (2008). The procedure of the individual studies is explained in more detail below.

General Design Science Cycle	First Design Cycles (DC1.1 & DC1.2)		Second Design Cycle (DC2)	
Awareness of Problem	User Interviews & Literature Review		Reflection of DC1	
Suggestion	User Stories, Kernel Theories, Meta-Requirements, and Design Principles		Refinement and Synthesis to a Final Set of Design Knowledge	
Development	Two Conceptual Prototypes of an LC		Derivation of Design Features for Guiding Future Instantiations	
Evaluation	User Test	Interdisciplinary Workshop	Focus Group Discussion	Expert Interviews
Conclusion	Meaningfulness of Design Knowledge with a greater Need to reduce Complexity		Design Knowledge is applicable and perceived positively	

Figure 1: DSR Procedure according to Kuechler & Vaishnavi (2008)

Procedure of the Individual Studies

Literature Review: We included five databases from the fields of information systems, computer science, business, and education. The search term consisted of CA synonyms (e.g., "*chatbot*"), combined with synonyms for requirements (e.g., "*study requirement*"), prescriptive recommendations (e.g., "*design principle*"), or features (e.g., "*design feature*") (Figure 3). Initially, we identified 424 hits from AIS eLibrary (54), ACM Digital Library (6), Scopus (350), IEEE Xplore (8), and ERIC (6). We systematically filtered them following the PRISMA statement (removing duplicates, title and abstract screening) (Moher, Liberati, Tetzlaff, & Altman, 2010). We excluded studies that either did not contribute design knowledge or were not related to education. Finally, we selected 48 publications for full-text analysis, which we clustered along with the virtual companion canvas (Strohmann & Robra-Bissantz, 2020). We used the findings as well as the kernel theories (Section II) as supporting literature to strengthen the design knowledge. Figure 2 illustrates the literature review procedure.

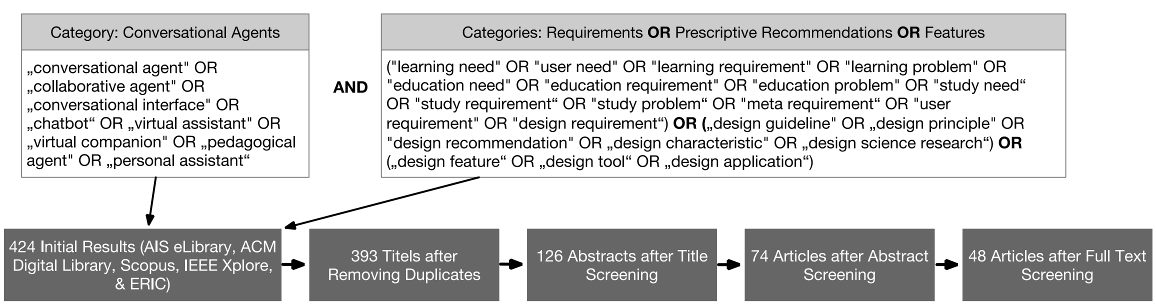

Figure 2: Literature Review Procedure

Interviews for Needs Assessment: A total of 14 semi-structured interviews were conducted with working students (six by team1, eight by team2). The interview guides possessed a focus on existing student challenges with time management & motivation (*problem space*) and elicitation of desires and DFs for VLCs (*solution space*) (vom Brocke, Winter, Hevner, & Maedche, 2020). We fully transcribed and coded all interviews using "*MAXQDA*". Team1 used inductive coding according to Mayring (2015) so that the codes emerged while reviewing the data. The coding scheme was divided into the main areas "*students' initial situation*" and "*design of the VLC*" and twelve subsequent categories. In total, team1 assigned 499 codings, and we then formulated USs based on these results. The USs were combined with literature findings to form MRs, which in turn led to DPs. Team 2 used deductive coding (Mayring, 2015) based on a pre-established coding guide, which follows the structure of the interview guide. Thereby, 28 codes and 287 codings were assigned. We first categorized the results, and then also formulated overarching MRs and DPs.

Evaluation Studies: To evaluate the results of team1, we conducted an online study in which the prototype designed based on the design knowledge was evaluated along with the recommendation of Venable et al. (2016) in terms of DP fulfillment. In addition, we elicited the quality and utility of the artifact (Hevner et al., 2004) using the "*system usability scale*" (Brooke, 1996). Our study involved 40 potential future users (learners) who watched a video demonstrating the prototype. We discussed the results of team2 in a workshop in which, in addition to the authors of this paper, nine other participants (lecturers/researchers, students, and developers) attended and evaluated the results from their respective roles in small groups. To evaluate the final results after synthesis in design cycle 2, we interviewed five experts (a focus group with three developers, a master's student with experience in designing learning applications, and a DSR & CA researcher). They assessed the design knowledge in terms of purpose achievement (time management and motivational support) as well as technological implementation by commenting on our findings while providing suggestions for adaptation. The procedure served to finally assess the artifact in terms of *feasibility, desirability, and viability* (Dolata & Schwabe, 2016). We initially presented the design knowledge to the experts which they later commented on using the Miro whiteboard. We recorded, transcribed, and analyzed the interviews. Although the experts did not introduce any additional DPs, they expressed supplemental MRs and DFs.

Figure 3 illustrates the procedure of the conducted interview studies (DC = Design Cycle; I = Interviewee).

	Interview Studies		
Key Information	Requirements Elicitation in DC1.1	Requirements Elicitation in DC1.2	Evaluation in DC2
Target Group	Working Students (6 Interviews)	Working Students (8 Interviews)	Experts (Focus Group with 3 Participants & 2 Further Interviews)
Participants (Professional Background)	Buyer (I1), Administration (I2), Mechatronics Engineering (I3), Computer Science (I4), HR (I5) & Financial Advisor (I6)	Technical Sales (I7), Marketing (I8), Process Management (I9), Road Testing D 3 (I10), Research Associate (I11), Junior Researcher (I12), Scrum Master (I13), Co-op Student (I14)	Educational Software Development (I15-17), Educational Software Design (I18), DSR/CA Researcher & Consultant (I19)
Foci of the Interview Guide	Challenges in Time Management & Motivation, Appropriate Coping Strategies, Desired Functions and Design Aspects of an LC	Challenges in Time Management & Motivation, Appropriate Coping Strategies, Desired Functions and Design Aspects of an LC	Assessment of Design Knowledge regarding Time Management and Motivation, Proposed Changes, Technological Feasibility
Duration	approx. 20-35 Minutes	approx. 20-55 Minutes	approx. 90-120 Minutes

Figure 3: Procedure of Interview Studies

IV. RESULTS

In the following, we present the results of the individual studies in a condensed form. For transparency, the results of the individual design cycles (initially formulated USs, mapping diagrams including all derived DF categories, and instantiated prototypes) are presented in detail in the **digital appendix**: https://bit.ly/3z6xzI5

Design Cycle 1: Initial Design Knowledge

Design Cycle 1.1: Based on 40 USs as well as 39 MRs, we formulated 13 resulting DPs with the following foci: *Human-likeness, friendship & relationship, VLC behavior* (proactive & reactive, motivating, self-acting, as well as persistent presence), *customization & adaptivity, transparency & privacy, functionality* (scheduling, task planning, skill building, learning support), and *user interface (UI) & usability*. To illustrate these, we instantiated a human-like VLC named "*Charlie*" using the design tool "*Virtual Companion Canvas*" by Strohmann & Robra-Bissantz (2020). Charlie provides multiple options for accompanying the learner via dialogue (e.g., reminders for appointments, motivation for learning progress as well as tips for studying). In addition, it is integrated into an app that provides further functions (e.g., to-do lists, and a view of the calendar). The results of the evaluation (fulfillment of the DPs and system usability scale) are summarized in Figure 4. Overall, the prototype was evaluated mostly positively, with potential for improvement in some categories (human likeness, friendship & relationship), which might arise from the fact that the respondents did not interact with a mature product. In addition, respondents suggested additional features (e.g., gamification and push notifications).

Design Categories	
Human-likeness	Mean Value: 3.10; Standard Deviation: 1.26
Friendship & Relationship	Mean Value: 3.50; Standard Deviation: 1.23
Behavior	Mean Value: 3.80; Standard Deviation: 1.23
Adaptability & Adaptivity	Mean Value: 3.60; Standard Deviation: 1.06
Quality (Functioning & UI)	Mean Value: 4.20; Standard Deviation: 0.69
Usability	
System Usability Scale	81.75 (Scale from 0-100 (Brooke, 1996))
Key Data on the Survey	
Scale: 1 = Does not apply at all; …; 5 = Applies completely; Participants: 40 (Mean Age: 27) with 93% Part-time Students and 7% Dual Students	

Figure 4: Evaluation Results of Charlie

Design Cycle 1.2: Based on 30 USs and 30 MRs, we derived 10 DPs. The first five are based on the DPs of Strohmann (2021) that were established for virtual companions, so we transferred them to the learning context: *Emotional dialogue and human-likeness, customization for personal needs & language, proactivity, (personal) data protection & accessibility, and relatedness*. In addition, we derived five DPs explicitly applicable to the learning context, which relate to *knowledge & motivation* (provision of learning content, motivational environment) and *functional properties* (task planning support, effective time management, compatibility & feasibility). Team2 created a prototype called "*Social Intelligent Learning Companion*" (SILC), which embodies a VLC providing learning recommendations and relevant learning content while encouraging networking with peers. Rather than the prototype itself, we evaluated the underlying design knowledge from SILC. The participants of the workshop validated the findings, although individual aspects were controversially discussed (e.g., to what extent providing time management tools is contrary to the idea of the VLC as a coequal partner (Strohmann et al., 2022)).

Design Cycle 2: Final Design Knowledge

In the following, we elaborate on the final set of design knowledge. Since for each DP, the implementers (CA developers), users (learners), and the context (interaction between VLC and working students) are identical, we do not repeat it in Figures 5-13 for clarity. In addition, all finally derived corresponding DF categories are available in the **digital appendix**: https://bit.ly/3z6xzI5.

First, we identified a human-like design of the VLC as crucial to promoting learners' trust (Feine et al., 2019; Seymour et al., 2018). Such social cues, along with the CASA Theory (Moon, 2000; Nass et al., 1994), promote social behavior among users as well as that they grant more credibility to the VLC (Demeure et al., 2011; Feine et al., 2019), i.e., by a human-like avatar evolving dynamically over time (e.g., by aging). In addition to appearance, communication and behavior reflect humanoid design, e.g., by the VLC conveying humor through telling jokes, addressing the learners' interests, or empathizing with emojis (Wambsganss et al., 2020). However, since users may perceive a too high degree of human-likeness negatively and it may lead to a decline in acceptance (also known as the "*uncanny valley*") (Mori, 2012), the degree of human-likeness should be chosen consciously and the VLC should not be designed to be over-human-like (Strohmann et al., 2022). Consequently, we recommend the VLC's design to be somehow human-like regarding its appearance, behavior, and actions by avoiding the uncanny valley (MR1). Since a VLC is an intelligent dialogue system, this includes its human-like communication, either through linguistic elements (using words, sentences) or non-verbal aspects (hand gestures, facial expressions) (Seeger, Pfeiffer, & Heinzl, 2021; Strohmann et al., 2022) (MR2). In addition, the VLC should possess social skills and exude sympathy to establish a personal bond (MR3), e.g., by taking into account emotional intelligence as well as the user's mood, similar to Replika (Skjuve et al., 2021). Thus, we propose DP1 of Human-likeness and Dialogue Management (Figure 5).

DP1: Human-likeness and Dialogue Management	
Aim	To enable learners to feel individually understood about their concerns, to perceive the VLC as a social interaction partner, and ultimately to trust it,
Mechanism	design the VLC somehow human-like through a human-like appearance (e.g., an avatar), human-like behaviors and actions (e.g., a humorous character or responding to learners' interests). Additionally, integrate human-like language (e.g., verbal, or non-verbal), as well as elements that exhibit the VLC's social skills and likability (e.g., emotion recognition and empathy).
Rationale	In accordance with CASA theory, the integration of social cues encourages people to behave socially toward the VLC and give it more credibility. In addition, learners desire emotional support and attention to their individual concerns to overcome learning challenges. Moreover, the degree of human-likeness should be chosen consciously and not be too high, to avoid the uncanny valley effect.

Figure 5: DP1 of Human-likeness and Dialogue Management

The interviews revealed the high individuality of learners' needs and habits, as they have different learning preferences, and apply a plethora of learning techniques and strategies (Dağ & Geçer, 2009; Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Moreover, virtual companionship is strongly perceived differently (Dautenhahn, 2004; Krämer et al., 2011; Strohmann et al., 2022). Therefore, we conclude the necessity for individualization, either through adaptability (MR4) by the user or through the VLC's adaptivity to the user's needs (Schlimbach, Rinn, et al., 2022). Adaptability includes the active selection of the VLC's role, i.e., whether the latter should act more as a tutor to deliver learning content or as a coequal partner or buddy. In terms of adaptivity, the VLC might adapt to the user's personality (Ahmad, Siemon, Gnewuch, & Robra-Bissantz, 2022), e.g., along the "*Big Five*" model (McCrae & John, 1992), and also take into account the learner's habits and behaviors (e.g., in the form of preferred times for learning reminders) (MR5). In addition, adaptivity to the characteristics of the learner should also take place (Plass & Pawar, 2020; Schlimbach, Rinn, et al., 2022) (MR6), e.g., by matching recommendations to the person's learning progress and ability level, or by taking into account individual learning styles and preferences (Dağ & Geçer, 2009; Plass & Pawar, 2020). Moreover, context-awareness is desirable (Fischer, 2012) (MR7), e.g., in that the communication style adapts to the situation (Iwase, Gushima, & Nakajima, 2021) as well as to the learner's mood (Diederich, Brendel, & Kolbe, 2019). To do so, the VLC might be both, friendly as well as admonishing in case of upcoming deadlines and promote the emergence of common ground during the interaction (Clark, 1992; Krämer et al., 2011; Strohmann et al., 2022). Furthermore, to address students' individual challenges (ranging from addressed difficulties in time management and motivation to comprehension gaps), it is relevant that the VLC addresses personal concerns (MR8), potentially enabled by advances of AI in natural language processing (Khosrawi-Rad, Rinn, et al., 2022). Thus, we propose DP2 of Adaptation (Figure 6).

DP2: Adaptation	
Aim	To assist learners individually in improving their learning as well as to increase the value in use of the VLC,
Mechanism	create both, features of adaptability of the VLC (e.g., the avatar or the personality) and adaptivity (e.g., the learner's personality, learning preferences and progress, the contextual situation, as well as their challenges and preferences).
Rationale	Learners have highly individual needs and habits (e.g., in terms of learning preferences and learning techniques used) and perceive virtual companionship very differently, so a one-size-fits-all solution for a VLC is not feasible. Adaptability allows learners to adjust the VLC to their own needs through setting options, and adaptivity (to the individual, learning variables, or contextual situation) further allows for contribution to user-adaptive learning, especially for variables benefitting the learning process that the learner might not be consciously aware of.

Figure 6: DP2 of Adaptation

To enable the benefits of a long-term virtual companionship, the VLC should exhibit both, proactive and reactive communication (Winkler & Roos, 2019). While many of CAs are characterized by purely reactive behavior (Seymour et al., 2018), virtual companions act proactively by initiating conversations and actively offering support to the user (Strohmann, Siemon, & Robra-Bissantz, 2019). Transferred to the educational context, the VLC should proactively and autonomously support learners for improved guidance in the learning process (Elshan & Ebel, 2020) (MR9), e.g., by independently contributing study tips or reminding them of upcoming deadlines and appointments (Rodriguez et al., 2019). Furthermore, surveyed students mentioned social media as a great distraction causing concentration problems for learning. Therefore, they desire features for the targeted avoidance of distractions while studying, e.g., by having the VLC block social media or play background music to facilitate concentration during timed learning sessions. Nevertheless, to support learners' upcoming individual concerns and inquiries, reactive behavior is also required (Winkler & Roos, 2019) (MR10). Thus, we propose DP3 of Proactive and Reactive Behavior (Figure 7).

DP3: Proactive and Reactive Behavior	
Aim	To enable the benefits of a long-term virtual companionship as well as to support learners with motivation and time management concerns,
Mechanism	approach learners autonomously (e.g., through tips and reminders), as well as, enable features for the proactive avoidance of distracting factors while learning (e.g., blocking social media, background music) and enable reactive behavior by responding and addressing learners' concerns and inquiries.
Rationale	Learners desire both, the proactive behavior of the VLC to not forget deadlines, to improve their learning process continuously through the VLC's guidance, and to not be distracted by social media, as well as the reactive behavior for the VLC to be able to address their specific concerns.

Figure 7: DP3 of Proactive and Reactive Behavior

The VLC in its role as a virtual companion should be permanently present and accessible (MR11) since interviewees emphasized the relevance of scalability and accessibility as a helpful and socially present interaction partner, which is also addressed in the literature (Elshan & Ebel, 2020; Hobert & Meyer von Wolff, 2019). Closely related is their expectation of having the VLC not only provide personalized support but also continuous and regular guidance (MR12), since continuity positively affects learning progress (Dunlosky et al., 2013). Moreover, building a personal relationship with a CA/VLC requires long-term use as a prerequisite for trust building and reliability (Nißen et al., 2021; Savin-Baden, Tombs, & Bhakta, 2015; Strohmann et al., 2022) (MR13). As a side effect, recurrent use allows for the collection of new interaction and learner data, thus increasing the quality of support provided by the VLC (Janssen, Grützner, & Breitner, 2021). Similar to Replika, this can be enabled, e.g., by empathetic communication and the accompanying emotional and mental support (Elshan & Ebel, 2020; Savin-Baden et al., 2015; Schlimbach, Khosrawi-Rad, et al., 2022). Thus, the VLC should promote the establishment as well as maintenance of a friendly relationship as well as a sense of belonging (MR14), e.g., by establishing common ground or by setting common goals (e.g., a team motto) to create a shared mental model between the VLC and its human partner (Elshan & Ebel, 2020; Strohmann & Robra-Bissantz, 2020). Thus, we propose DP4 of Relationship Building (Figure 8).

DP4: Relationship Building	
Aim	To foster the long-term use of the VLC and thus increase the perception of reliability and acceptance,
Mechanism	enable constant presence and accessibility of the VLC, accompany learners regularly and focus towards building a trustful as well as friendly relationship and a sense of belonging with the VLC, e.g., by providing emotional and mental support, by building a common ground in conversations as well as a shared mental model (e.g., setting mutual goals or a team motto).
Rationale	Learners desire continuous and friendly accompaniment by the VLC so that they perceive the VLC as a socially present interaction partner. Building a bond of trust between the VLC and the user promotes acceptance by users according to the theory of interpersonal trust. The regular guidance by the VLC is also necessary because distributed learning over a longer period is required for long-term learning success, and because the VLC itself can increasingly better support the learner through the newly acquired training data.

Figure 8: DP4 of Relationship Building

To enable learning effects in long-term use, the interviewed students and experts emphasized that content facilitating learning (e.g., recommended learning techniques or subject-related resources) needs to be integrated into the VLC continuously (MR15). Thus, a solid knowledge base is necessary, so that learners perceive the VLC not only as a friend but also as a competent learning facilitator. Since several interviewees found it difficult to apply the learning content to their jobs, its practical relevance is crucial (MR16). At the functional level, this involves conveying content as well as answering specific questions via dialogue to reap the benefits of interactive learning according to the ICAP framework (Chi & Wylie, 2014). In addition, the VLC could also link to external content such as tutorials or integrate challenges (e.g., exercises) to allow learners to apply the content practically and prepare for the exam (Dunlosky et al., 2013). The surveyed students perceived the organization of learning materials as challenging, esp. due to the lack of time alongside their jobs. Thus, they expressed the desire to be supported in compiling learning materials, e.g., by providing references to relevant literature or opportunities to share learning materials. Thus, we propose DP5 regarding the Provision of Supportive Content (Figure 9).

DP5: Provision of Supportive Content	
Aim	To contribute to increasing the learning success of working students,
Mechanism	integrate content that supports learning (e.g., by teaching learning techniques as well as specific subject matter), build a knowledge base to guide learners competently (e.g., literature), and support the transferability of the learning material to the everyday work life (e.g., through exercises).
Rationale	Learners desire to get support in organizing the learning material as well as to receive material from the VLC that accompanies their own learning process. In addition, along the ICAP framework, interactive learning through dialogue with the VLC promotes learning success, and the provision of material for practice contributes to learners being able to prepare for the exam and memorize the learning content.

Figure 9: DP5 regarding the Provision of Supportive Content

Furthermore, according to self-determination theory, the development of users' own study skills leads to higher self-confidence in terms of their competence and staying motivated (Lechler, Stöckli, Rietsche, & Uebernickel, 2019; Ryan & Deci, 2000) as well as perceiving that they are responsible for their own learning success (Schlimbach, Khosrawi-Rad, et al., 2022). Since the students interviewed primarily reported difficulties with time management and motivation, we conclude the relevance to have them acquire competencies in successful learning ("*how to learn*") (MR17). This could be realized, e.g., by feeding learning advice into the VLC that fits the specific learning challenges of its users or to encourage them to self-directed learning to overcome challenges on their own (experience self-efficacy) (Wollny et al., 2021) (MR18). To promote self-efficacy, the VLC could, e.g., encourage self-reflection through targeted questions and take on a mentoring role (Khosrawi-Rad, Rinn, et al., 2022; Wollny et al., 2021). Thus, we propose DP6 regarding the Fostering of Learning Competencies (Figure 10).

DP6: Fostering Learning Competencies	
Aim	To promote self-confidence regarding the competencies of the learners,
Mechanism	enable learners to acquire competency in time management as well as learning strategies and support learners in choosing and applying concrete learning techniques and strategies by providing learning advice and tips. Furthermore, encourage and enable students to become self-directed learners and build self-efficacy, e.g., by reflecting on their individual progress.
Rationale	Learners desire to gain more skills in *„how to learn“* and additionally, acquiring their own study skills is crucial so that learners experience the ease of solving challenges on their own, thus valuing their own competencies and staying motivated in the long run according to the self-determination theory.

Figure 10: DP6 regarding the Fostering of Learning Competencies

To ensure the long-term benefits of the VLC as well as to promote learner engagement, persuasive features (game elements and digital nudging) should be embedded (MR19) (Benner, Schöbel, & Janson, 2021; Benner et al., 2022). These design elements promote fun in learning (Benner et al., 2022), encourage the emergence of flow effects (Csikszentmihalyi, 1975), and promote the perception of competence (Lechler et al., 2019; Ryan & Deci, 2000). E.g., a quiz could be integrated into the dialogue, or positive learning experiences could be rewarded with points (Benner et al., 2022). In addition, providing feedback to learners (MR20) contributes to rewarding learners for positive performance and thus also fosters flow effects (Csikszentmihalyi, 1975; Lechler et al., 2019; Ryan & Deci, 2000) as well as making learning progress visible (Wambsganss et al., 2020). Encouraging and friendly communication should accompany gamification (Strohmann et al., 2022; Wollny et al., 2021), e.g., by the VLC congratulating the learner on progress. For a motivating learning environment, respondents also value features for social networking (MR21), which could be implemented, e.g., by recommending learning groups (similar to Jill Watson) (Wang et al., 2020). This is relevant because many respondents considered the (corona-related) lack of contact with fellow students as a key challenge, while interactive learning along the ICAP framework favors strong learning outcomes (Chi & Wylie, 2014). Thus, we propose DP7 of Motivational Environment (Figure 11).

DP7: Motivational Environment	
Aim	To keep students motivated or even increase their engagement,
Mechanism	integrate persuasive design elements into the VLC (gamification and digital nudging, e.g., through reward elements), ensure that learners receive feedback and encourage them though friendly communication, as well as enable social interactions with peers (e.g., though a networking function).
Rationale	Gamification and digital nudging create positive motivational effects related to learning, e.g., to enhance fun, the perception of competence, or the emergence of flow effects. Direct feedback also contributes to flow effects, and friendly communication through the VLC allows users to be encouraged to learn (e.g., during a motivational low). Promoting learning with peers helps learners feel comfortable and socially included and contributes to the benefits of interactive learning according to the ICAP framework as well.

Figure 11: DP7 of Motivational Environment

Furthermore, the consideration of ethical accountability in VLC design is crucial (Schlimbach, Khosrawi-Rad, et al., 2022). For learners to trust the VLC, transparency is relevant (MR22) so that users understand how their data is stored and processed and how the VLC arrives at its decisions (Strohmann et al., 2022; Wambsganss et al., 2021). To ensure fairness, the VLC should treat learners equally and avoid discriminatory bias (Schlimbach, Khosrawi-Rad, et al., 2022;

Wambsganss et al., 2021) (MR23). Thus, the VLC should not give preferential treatment to individual learners, and "*algorithmic bias*" (the propagation of discriminatory practices by an AI algorithm) needs to be reduced, e.g., by using technical barriers to prevent the inclusion of vulgar expressions (Casas-Roma & Conesa, 2021; Schlimbach, Khosrawi-Rad, et al., 2022; Wambsganss et al., 2021). In this context, an ethical code of the VLC is key (MR24), i.e., following ethical guidelines for the use of AI in general (European Commission, 2021; OECD, 2019) and VLCs in particular (Schlimbach, Khosrawi-Rad, et al., 2022) during its design. For instance, this should include allowing learners to freely customize the avatar (gender, ethnicity) as well as fostering inclusion (e.g., voice control as a feature) (ibid.). Thus, we propose DP8 of Ethical Responsibility (Figure 12).

DP8: Ethical Responsibility	
Aim	To ensure the ethically responsible use of VLCs and thus foster its' acceptance,
Mechanism	The VLC should ensure transparency through functions of explainability, behave in a non-discriminatory manner toward learners, ensure equality (e.g., trough functions of customizability), and comply with an ethical code.
Rationale	Transparency contributes to the perception of trust towards the VLC, and non-discriminatory behavior, as well as maintaining equality and an ethical context, is crucial for the VLC to behave fairly toward learners.

Figure 12: DP8 of Ethical Responsibility

To fulfill the aforementioned DPs and satisfy users, the feature scope and ease of use of the VLC are essential. On a functional level, task planning (MR25), as well as time management (MR26) to address challenges of organizing daily study life (Rodriguez et al., 2019), are major requirements, i.e., the provision of suitable suggested dates for learning (considering the individual schedule), assistance in generating personalized learning plans, or setting reminders of breaks in learning. In terms of enabling effective time management, users aim for to-do lists in the application, wish to receive an overview of upcoming deadlines, and reminders of tasks to be completed via push notifications. Considering technological feasibility and integration into existing workflows, the VLC must be compatible with other tools enabling the integration of different media sources (MR27). Thus, linking internal as well as external interfaces is important, e.g., by connecting to Google Calendar for scheduling support or by enabling the VLC to send external links to YouTube videos or literature from the university's online database. To ensure usability, a sleek UI that balances the application's functionality, and clarity prevents cognitive load (Mayer & Moreno, 2003; Paas, Renkl, & Sweller, 2003). Consequently, simple, intuitive, fast, and low error-prone use is relevant. In this context, the customizability of the UI leads to satisfying the users' need for autonomy (Lechler et al., 2019; Ryan & Deci, 2000). This may involve configurable settings, such as selectable communication styles or notifications to be turned on or off (Schlimbach & Khosrawi-Rad, 2022). Finally, in the spirit of participatory design, users should be actively involved in the design from early on (MR28) through co-creation processes, including integrated evaluations with the target group (Abras et al., 2004). Thus, we propose DP9 of Purpose-oriented Functionality and Usability (Figure 13).

DP9: Purpose-oriented Functionality & Usability	
Aim	To best support learners in achieving learning success and to create a positive user experience,
Mechanism	provide multiple functions for task planning (e.g., reminders), time management (e.g., to-do lists), and interfaces to other tools and learning platforms, combined with high usability and a sleek UI that balances the application's functionality. Furthermore, VLC users should be actively involved in its design.
Rationale	Learners consider time management to be a key challenge in learning, and desire multiple features for task scheduling and to support effective time management. To integrate the VLC into their existing workflow, this requires the creation of interfaces to existing tools, and the avoidance of cognitive overload. Furthermore, learners desire to be able to turn features on and off according to their own preferences in the spirit of user-centered design, as well as to be involved in the design process itself so that the VLC matches the needs of the target group.

Figure 13: DP9 of Purpose-oriented Functionality and Usability

V. DISCUSSION

The participants of the evaluation studies discussed individual aspects of design knowledge controversially along with the DSR cycles. E.g., the focus group consisting of I15-I17 questioned the relevance of the human-like nature of the VLC, e.g., because users might be distracted from the actual goal of learning. The research community also discussed the human-likeness of CAs controversially in recent years (e.g., Clark et al., 2019; Feine et al., 2019; Seeger et al., 2021; Siemon et al., 2022). Thus, designers should use human-like elements judiciously to avoid negative perceptions such as the "*uncanny valley*" or a looming lack of trust if the design is too human-like (Mori, 2012; Strohmann et al., 2022). These findings are consistent with the results of further studies, according to which users perceive virtual companionship very differently (Dautenhahn, 2004; Krämer et al., 2011; Strohmann et al., 2022). While some users are excited about the advances of AI, others perceive it as irrelevant or even threatening (Clark et al., 2019; Strohmann et al., 2022). To mitigate this effect, we would like to highlight DP2 (adaptation): During the interviews and review of the literature, it became clear that a "*one-size-fits-all solution*" for VLCs cannot exist (Benner et al., 2022). We recommend considering adaptation to implement an ethically acceptable product and to support as many learners as possible, e.g., the human resemblance or further design aspects (avatar, voice, gender) should be selectable according to the learners' preferences (Schlimbach & Khosrawi-Rad, 2022) and the VLC should adapt to the learners' personality (Ahmad et al., 2022). During the workshop, we also discussed the role of the VLC, as pedagogical CAs can take on different roles such as tutors, motivators, or organizers (Khosrawi-Rad, Rinn, et al., 2022). In that context, the organizer functions desired by many students (personalized appointment suggestions, timers, to-do lists) were questioned as to whether the VLC in this role serves more as a "*coach*" (superior to the learners) rather than a peer. Since the range of possible design functions as well as VLC roles show that collaboration between humans and VLC can occur in versatile ways, adaptability is crucial again. In addition, it should be possible to deactivate functions, e.g., if a learner does not want personalized appointment suggestions based on the fed-in data.

Moreover, the interviewees discussed the technological implementation. Regarding the integration of the VLC into existing infrastructures, I15-17 propose to embed the VLC into a learning management system to collect learner data as well as to provide targeted suggestions (e.g., for specific learning content). The idea of integrating the VLC into a smartphone app was also reiterated, e.g., to view appointments, with I19 emphasizing the relevance of maximizing the flexibility of VLC use in terms of time, place, and device (e.g., via both, messenger, and an app). While all DPs are technologically feasible in their own right, for individual DFs, the participants partially questioned the feasibility according to the current state of the art. For instance, I19 noted that the implementation of emotional intelligence (e.g., sentiment analysis) might be prone to errors. Since the categories of DFs currently offer a lot of design freedom for implementing a VLC, the designer team ultimately needs to decide which DFs fit best in each application context. Although that is challenging, CA design is constantly evolving, which also makes it easier to create CAs, e.g., using building platforms like "*Google Dialogflow*" (Diederich et al., 2019). To this end, our underlying

DPs are meant to act as a theoretical foundation for designing innovative learning support artifacts (Gregor et al., 2020; Hevner et al., 2004).

VI. CONCLUSION

Significance to Research and Practice

We contribute to a better understanding of how VLCs should be designed to promote learners' motivation and time management with the nine DPs that we derived as a result of a method triangulation. The DPs emerged as part of a DSR project and are subdivided into a total of 28 MRs, which aim to support developers and designers at an abstract level in the design of VLCs. The 33 associated DF categories as well as the instantiations that have emerged, also exemplify how VLCs should be designed along with design knowledge (Möller et al., 2020). The rise in publications on pedagogical CAs, as well as advances in AI, illustrate that the educational context may be increasingly shaped by technology-enhanced learning opportunities in the upcoming years (Hobert & Meyer von Wolff, 2019; Khosrawi-Rad, Rinn, et al., 2022; Wollny et al., 2021). This article strives to better understand this changing collaboration between humans and intelligent machines in the educational context by providing prescriptive design recommendations for VLCs.

Limitations

We admit some limitations: First, the evaluation of existing design knowledge has so far relied primarily on expert views and the results of an online study, rather than listing results from real interactions with a VLC. Second, the subjective influence of respondents, as well as researchers in deriving design aspects, cannot be ruled out. We have taken steps to mitigate these limitations: The design knowledge was established both by consulting the users (user-centered design) and the existing knowledge base, and to reduce bias, it was derived and refined in several iterations by researchers working independently of each other.

Outlook

Currently, we are working on the transfer of the design knowledge into a functional VLC. For this purpose, we are currently developing a VLC with the building platform "*Google Dialogflow*", which is a common tool for deploying CAs (Diederich et al., 2019). The platform allows connecting to external tools like Google Calendar or services for adaptation (e.g., sentiment analysis), as well as integrating scripts and databases for storing and processing learner data. In addition, we are incorporating the VLC into an application using the "*Flutter*" development tool, since many of the DFs (e.g., timers, to-do lists, customization functions) can be illustrated better in this way than through pure dialogue, and we can ensure platform-independent development. In the sense of MR28 (participatory design), the next steps are the further development by involving the target group again and the iterative testing of individual DFs in a more mature prototype. Therefore, we plan to test the instantiated VLCs concerning the individual constructs mentioned in the "*aims*" part of each DP against a baseline artifact that does not satisfy the DPs.

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LIST OF REFERENCES

Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, *37*(4), 445–456.

Ahmad, R., Siemon, D., Gnewuch, U., & Robra-Bissantz, S. (2022). Designing Personality-Adaptive Conversational Agents for Mental Health Care. *Information Systems Frontiers*, 1–21.

Atkinson, R. C. (1968). Computerized instruction and the learning process. *American Psychologist*, *23*(4), 225.

Benner, D., Schöbel, S., & Janson, A. (2021). Exploring the State-of-the-Art of Persuasive Design for Smart Personal Assistants. *Wirtschaftsinformatik 2021 Proceedings*. Essen, Germany.

Benner, D., Schöbel, S., Süess, C., Baechle, V., & Janson, A. (2022). Level-Up your Learning – Introducing a Framework for Gamified Educational Conversational Agents. *Wirtschaftsinformatik 2022 Proceedings*. Nürnberg, Germany.

Bødker, S., & Kyng, M. (2018). Participatory design that matters—Facing the big issues. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *25*(1), 1–31.

Brooke, J. (1996). Sus: A "quick and dirty'usability. *Usability Evaluation in Industry*, *189*(3), 189–194.

Casas-Roma, J., & Conesa, J. (2021). Towards the Design of Ethically-Aware Pedagogical Conversational Agents. *Proceedings of the 15th International Conference on P2P, Parallel, Grid, Cloud and Internet Computing*, 188–198, Fukuoka, Japan.

Chi, M. T. H., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes. *Educational Psychologist*, *49*(4), 219–243.

Clark, H. (1992). *Arenas of language use*. University of Chicago Press.

Clark, L., Pantidi, N., Cooney, O., Doyle, P., Garaialde, D., Edwards, J., … Cowan, B. R. (2019). What Makes a Good Conversation? Challenges in Designing Truly Conversational Agents. *CHI Conference on Human Factors in Computing Systems Proceedings,* New York, USA.

Csikszentmihalyi, M. (1975). Play and Intrinsic Rewards. *Journal of Humanistic Psychology*, *15*(3), 41–63.

Dağ, F., & Geçer, A. (2009). Relations between online learning and learning styles. *Procedia - Social and Behavioral Sciences*, *1*(1), 862–871.

Dautenhahn, K. (2004). Robots we like to live with?!-a developmental perspective on a personalized, life-long robot companion. *RO-MAN 2004. 13th IEEE International Workshop on Robot and Human Interactive Communicatio*, 17–22. Kurashiki, Japan.

Demeure, V., Niewiadomski, R., & Pelachaud, C. (2011). How is believability of a virtual agent related to warmth, competence, personification, and embodiment? *Presence*, *20*(5), 431–448.

Diederich, S., Brendel, A. B., & Kolbe, L. M. (2019). Towards a Taxonomy of Platforms for Conversational Agent Design. *Wirtschaftsinformatik 2019 Proceedings*. Siegen, Germany.

Dolata, M., & Schwabe, G. (2016). Design thinking in IS research projects. In *Design thinking for innovation* (pp. 67–83). Springer.

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychological Science in the Public Interest: A Journal of the American Psychological Society*, *14*(1), 4–58.

Elshan, E., & Ebel, P. (2020). Let's Team Up: Designing Conversational Agents as Teammates. *ICIS 2020 Proceedings*. Hyderabad, India.

European Commission. (2021). *Proposal for a regulation of the European parliament and of the council laying down harmonised rules on artificial intelligence (artificial intelligence ACT) and amending certain union legislative acts*. Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206

Feine, J., Gnewuch, U., Morana, S., & Maedche, A. (2019). A Taxonomy of Social Cues for Conversational Agents. *International Journal of Human-Computer Studies*, *132*, 138–161.

Finster, R., & Robra-Bissantz, S. (2020). Not just Skills and Knowledge – Fostering Competencies in Information Systems Education. *AMCIS 2020 Proceedings*. Salt Lake City, USA.

Fischer, G. (2012). Context-aware systems: The'right'information, at the'right'time, in the'right'place, in the'right'way, to the'right'person. *Proceedings of the International Working Conference on Advanced Visual Interfaces*, 287–294. Capri Island, Italy.

Gregor, S., Chandra Kruse, L., & Seidel, S. (2020). The Anatomy of a Design Principle. *Journal of the Association for Information Systems*, *21*, 1622–1652.

Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science research for maximum impact. *MIS Quarterly*, *37*(2), 337–355.

Grivokostopoulou, F., Kovas, K., & Perikos, I. (2020). The Effectiveness of Embodied Pedagogical Agents and Their Impact on Students Learning in Virtual Worlds. *Applied Sciences*, *10*(5), 1739.

Gubareva, R., & Lopes, R. P. (2020). Virtual assistants for learning: A systematic literature review. *Proceedings of the 12th International Conference on Computer Supported Education*, *1*, 97–103.

Hevner, A., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105.

Hobert, S., & Meyer von Wolff, R. (2019). Say Hello to Your New Automated Tutor – A Structured Literature Review on Pedagogical Conversational Agents. *Wirtschaftsinformatik 2019 Proceedings*. Siegen, Germany.

Iwase, K., Gushima, K., & Nakajima, T. (2021). "Relationship Between Learning by Teaching with Teachable Chatbots and the Big 5. *2021 IEEE 3rd Global Conference on Life Sciences and Technologies (LifeTech)*, 191–194. San Jose, USA.

Janssen, A., Grützner, L., & Breitner, M. H. (2021). Why do Chatbots fail? A Critical Success Factors Analysis. *ICIS 2021 Proceedings*. Austin, USA.

Khosrawi-Rad, B., Rinn, H., Schlimbach, R., Gebbing, P., Yang, X., Lattemann, C., … Robra-Bissantz, S. (2022). Conversational Agents in Education – A Systematic Literature Review. *ECIS 2022 Proceedings*. Timișoara, Romania.

Khosrawi-Rad, B., Schlimbach, R., & Robra-Bissantz, S. (2022). Gestaltung virtueller Lern-Companions durch einen Co-Creation Prozess. *Wirtschaftsinformatik 2022 Proceedings*. Nürnberg, Germany.

Krämer, N. C., Eimler, S., Pütten, A. von der, & Payr, S. (2011). Theory of Companions: What Can Theoretical Models Contribute to Applications and Understanding of Human-Robot Interaction? *Applied Artificial Intelligence*, *25*(6), 474–502.

Kuechler, B., & Vaishnavi, V. (2008). On theory development in design science research: Anatomy of a research project. *European Journal of Information Systems*, *17*(5), 489–504.

Kulik, J. A., & Fletcher, J. (2016). Effectiveness of intelligent tutoring systems: A meta-analytic review. *Review of Educational Research*, *86*(1), 42–78.

Lechler, R., Stöckli, E., Rietsche, R., & Uebernickel, F. (2019). Looking beneath the tip of the Iceberg: The two-Sided Nature of Chatbots and their Roles for Digital feedback Exchange. *ECIS 2019 Proceedings*. Stockholm and Uppsala, Sweden.

Lester, J. C., Converse, S. A., Kahler, S. E., Barlow, S. T., Stone, B. A., & Bhogal, R. S. (1997). The persona effect: Affective impact of animated pedagogical agents. *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems,* 359–366. Montréal and Québec, Canada.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43–52.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12., überarbeitete Auflage). Weinheim Basel: Beltz Verlag.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality*, *60*(2), 175–215.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2010). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery*, *8*(5), 336–341.

Möller, F., Guggenberger, T. M., & Otto, B. (2020). Towards a Method for Design Principle Development in Information Systems. *DESRIST 2020 Proceedings*, Kristiansand, Norway.

Moon, Y. (2000). Intimate Exchanges: Using Computers to Elicit Self-Disclosure from Consumers. *Journal of Consumer Research*, *26*(4), 323–339.

Mori, M. (2012). The Uncanny Valley: The Original Essay by Masahiro Mori. Retrieved June 26, 2019, from IEEE Spectrum: Technology, Engineering, and Science News website: https://spectrum.ieee.org/automaton/robotics/humanoids/the-uncanny-valley

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 72–78.

Nißen, M., Selimi, D., Janssen, A., Cardona, D., Breitner, M., Kowatsch, T., & Wangenheim, F. (2021). See you soon again, chatbot? A design taxonomy to characterize user-chatbot relationships with different time horizons. *Computers in Human Behavior*, *127*(2).

OECD. (2019, June 2). What are the OECD Principles on AI? Retrieved April 21, 2022, from OECD Observer website: https://www.oecd-ilibrary.org/economics/what-are-the-oecd-principles-on-ai_6ff2a1c4-en

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational Psychologist*, *38*(1), 1–4.

Plass, J. L., & Pawar, S. (2020). Toward a taxonomy of adaptivity for learning. *Journal of Research on Technology in Education*, *52*(3), 275–300.

Ranjbartabar, H., & Richards, D. (2018). Towards an Adaptive System: Users' Preferences and Responses to an Intelligent Virtual Advisor based on Individual Differences. *Designing Digitalization (ISD2018 Proceedings)*, 12.

Rodriguez, J., Piccoli, G., & Bartosiak, M. (2019). Nudging the Classroom: Designing a Socio-Technical Artifact to Reduce Academic Procrastination. *HICSS 2019 Proceedings*, Maui, USA.

Rotter, J. B. (1980). Interpersonal trust, trustworthiness, and gullibility. *American Psychologist*, *35*(1), 1–7.

Ryan, R., & Deci, E. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. *The American Psychologist*, *55*, 68–78.

Savin-Baden, M., Tombs, G., & Bhakta, R. (2015). Beyond robotic wastelands of time: Abandoned pedagogical agents and new pedalled pedagogies. *E-Learning and Digital Media*, *12*(3–4), 295–314.

Schlimbach, R., & Khosrawi-Rad, B. (2022). Towards Ethical Design Features for Pedagogical Conversational Agents. *AMCIS 2022 Proceedings*. Minneapolis, USA.

Schlimbach, R., Khosrawi-Rad, B., & Robra-Bissantz, S. (2022). Quo Vadis: Auf dem Weg zu Ethik-Guidelines für den Einsatz KI-baisierter Lern-Companions in der Lehre? *HMD Praxis der Wirtschaftsinformatik*, *59*(2).

Schlimbach, R., Rinn, H., Markgraf, D., & Robra-Bissantz, S. (2022). A Literature Review on Pedagogical Conversational Agent Adaptation. *PACIS 2022 Proceedings*. Taipei-Sydney.

Seeger, A.-M., Pfeiffer, J., & Heinzl, A. (2021). Texting with humanlike conversational agents: Designing for anthropomorphism. *Journal of the Association for Information Systems*, *22*(4), 8.

Seymour, M., Riemer, K., & Kay, J. (2018). Actors, Avatars and Agents: Potentials and Implications of Natural Face Technology for the Creation of Realistic Visual Presence. *Journal of the Association for Information Systems*, *19*(10).

Siemon, D., Strohmann, T., Khosrawi-Rad, B., de Vreede, T., Elshan, E., & Meyer, M. (2022). Why Do We Turn to Virtual Companions? A Text Mining Analysis of Replika Reviews. *AMCIS 2022 Proceedings*. Minneapolis, USA.

Skjuve, M., Følstad, A., Fostervold, K. I., & Brandtzaeg, P. B. (2021). My Chatbot Companion—A Study of Human-Chatbot Relationships. *International Journal of Human-Computer Studies*, *149*, 102601.

Strohmann, T., & Robra-Bissantz, S. (2020). A Virtual Companion for the Customer – From Conversation to Collaboration. In M. Bruhn & K. Hadwich (Eds.), *Automatisierung und Personalisierung von Dienstleistungen: Methoden – Potenziale – Einsatzfelder* (pp. 253–271). Wiesbaden: Springer Fachmedien.

Strohmann, T., Siemon, D., Khosrawi-Rad, B., & Robra-Bissantz, S. (2022). Toward a design theory for virtual companionship. *Human–Computer Interaction*, *0*(0), 1–41.

Strohmann, T., Siemon, D., & Robra-Bissantz, S. (2019). Designing Virtual In-vehicle Assistants: Design Guidelines for Creating a Convincing User Experience. *AIS Transactions on Human-Computer Interaction*, *11*(2), 54–78.

Suppes, P., & Morningstar, M. (1969). Computer-Assisted Instruction: Two computer-assisted instruction programs are evaluated. *Science*, *166*(3903), 343–350.

Venable, J., Pries-Heje, J., & Baskerville, R. (2016). FEDS: A Framework for Evaluation in Design Science Research. *European Journal of Information Systems*, *25*(1), 77–89.

vom Brocke, J., Winter, R., Hevner, A., & Maedche, A. (2020). Accumulation and Evolution of Design Knowledge in Design Science Research—A Journey Through Time and Space. *Journal of the Association for Information Systems*, *21*, 520–544.

Wambsganss, T., Höch, A., Zierau, N., & Söllner, M. (2021). Ethical Design of Conversational Agents: Towards Principles for a Value-Sensitive Design. *Wirtschaftsinformatik 2021 Proceedings*. Essen, Germany.

Wambsganss, T., Söllner, M., & Leimeister, J. M. (2020). Design and evaluation of an adaptive dialog-based tutoring system for argumentation skills. *ICIS 2020 Proceedings*. Hyderabad, India.

Wang, Q., Jing, S., Camacho, I., Joyner, D., & Goel, A. (2020). Jill Watson SA: Design and Evaluation of a Virtual Agent to Build Communities Among Online Learners. *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–8. Honolulu, USA.

Weber, F., Wambsganss, T., Rüttimann, D., & Söllner, M. (2021). Pedagogical Agents for Interactive Learning: A Taxonomy of Conversational Agents in Education. *ICIS 2021 Proceedings*. Austin, USA.

Winkler, R., & Roos, J. (2019). Bringing AI into the Classroom: Designing Smart Personal Assistants as Learning Tutors. *ICIS 2019 Proceedings*. Munich, Germany.

Wollny, S., Schneider, J., Di Mitri, D., Weidlich, J., Rittberger, M., & Drachsler, H. (2021). Are We There Yet? - A Systematic Literature Review on Chatbots in Education. *Frontiers in Artificial Intelligence*, *4*, 18.

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