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Design Knowledge for Virtual Learning Companions from a Value-centered Perspective

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Abstract:

The increasing popularity of conversational agents such as ChatGPT has sparked interest in their potential use in educational contexts but undermines the role of companionship in learning with these tools. Our study targets the design of virtual learning companions (VLCs), focusing on bonding relationships for collaborative learning while facilitating students' time management and motivation. We draw upon design science research (DSR) to derive prescriptive design knowledge for VLCs as the core of our contribution. Through three DSR cycles, we conducted interviews with working students and experts, held interdisciplinary workshops with the target group, designed and evaluated two conceptual prototypes, and fully coded a VLC instantiation, which we tested with students in class. Our approach has yielded 9 design principles, 28 meta-requirements, and 33 design features centered around the value-in-interaction. These encompass Human-likeness and Dialogue Management, Proactive and Reactive Behavior, and Relationship Building on the Relationship Layer (DP1,3,4), Adaptation (DP2) on the Matching Layer, as well as Provision of Supportive Content, Fostering Learning Competencies, Motivational Environment, and Ethical Responsibility (DP5-8) on the Service Layer.

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

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1 Introduction

Higher education has seen substantial changes in recent years, owing to technology breakthroughs and rising demand for (remote) digital learning. As students navigate this changing educational environment, there is an increasing demand for novel tools and ways to facilitate their learning journeys (Ngwacho, 2023). The fast-paced and increasingly digital work environment also demands professionals to continuously acquire new skills and knowledge (Finster & Robra-Bissantz, 2020). Lifelong learning has become crucial for professional development, especially for working students who face the double burden of work and study. For that reason, we target this specific group in our research. Technological progress and the trend toward digital learning have created new opportunities for professional development but have also made it more challenging for working students to motivate themselves and manage their time effectively (Rodriguez et al., 2019; Wang et al., 2020). Furthermore, digital learning is shifting from traditional instruction to collaboration between the teacher, students, and their peers. Collaborative learning describes an approach that uses social interaction as a means of knowledge building and implies that *"educators must trust students to perform in ways that the teacher has not necessarily determined ahead of time"* (Roberts, 2004, p. 204). Mutual engagement and the application of future skills such as critical thinking, creativity, communication, and collaboration are vital in this regard (Finster & Robra-Bissantz, 2020), as (collaborative) learning goes far beyond the pure transfer of knowledge.

In this context, virtual learning companions (VLCs), naturally interacting chatbots or voicebots, in their role as digital, humanoid learning facilitators that establish strong relationships with their users, may offer an innovative approach to support (working) students in learning (Grivokostopoulou et al., 2020; Khosrawi-Rad, Schlimbach, et al., 2022; Schlimbach, Khosrawi-Rad, et al., 2022). They collaborate as conversational virtual partners with students to motivate (e.g., Grivokostopoulou et al., 2020; Khosrawi-Rad, Rinn, et al., 2022) and improve their time management in the long run (Schlimbach, Windolf, et al., 2023) - two critical factors that impact students' success in further education (Rinn et al., 2022). Several studies have demonstrated the effectiveness of VLCs in fostering learners' motivation and improving their time management skills (Grivokostopoulou et al., 2020; Rodriguez et al., 2019). However, they do not consider that students actively engage in learning together with the VLC to then form a bonding relationship as a prerequisite to facilitate learning as a whole (Schlimbach, Windolf, et al., 2023). Scientific contributions have primarily focused on functional design aspects such as goal setting (e.g., Chen et al., 2022; Du et al., 2021), scheduling services (e.g., Inie & Lungu, 2021), or features for productivity increase (Kimani et al., 2019). Moreover, there is a lack of prescriptive design knowledge for VLCs (Khosrawi-Rad, Rinn, et al., 2022; Strohmann et al., 2022) that takes a more holistic approach to learning facilitation while considering the needs of working students who face multiple workloads. In addition, current research has not adequately addressed the closely intertwined issues of time management and motivation, as they target these challenges separately (e.g., Schlimbach, Windolf, et al., 2023). Finally, a current design study on VLCs (Schlimbach, Windolf, et al., 2023) has found that a service perspective accounting for the value created in interacting (Geiger et al., 2021) remains undiscovered, potentially co-causing their high failure rate in practice (Janssen et al., 2021). To address these research gaps, we propose a service-oriented view on the design of VLCs by deriving meta-requirements (MRs), design principles (DPs), and design features (DFs) for VLCs. Therefore, we aim to answer the following research question (RQ).

> **RQ: How to design VLCs to facilitate learning regarding effective time management and motivation from a value-centered perspective?**

We iteratively conducted three complete design and evaluation cycles along the design science research paradigm. By doing so, we aim to contribute to the design knowledge of VLCs and offer insights for educators and researchers to create effective VLCs (especially) for working students. Our research thus contributes to the current debate on innovative approaches in higher education.

2 Research Background

Our approach stands out due to its innovative focus on creating a socially bonding companion that fosters collaboration compared to more task-oriented, reactive, and assisting agents. Therefore, Section 2.1 establishes a literature-based foundation for the shift from pedagogical assistance to companionship. Building upon this, in Section 2.2, we introduce kernel theories that form the rigorous knowledge base for deriving our design principles. Section 2.3 supplements these with further concepts that we selectively incorporate into the design knowledge derived in this paper. Finally, Section 2.4 introduces the proposed, unconventional value-centered perspective on VLCs.

2.1 From Pedagogical Conversational Agents to Virtual Learning Companions

VLCs have their origins in so-called pedagogical conversational agents (PCAs), which communicate with their users and are 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). PCAs, 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 PCAs has now become broader (Khosrawi-Rad, Rinn, et al., 2022; Weber et al., 2021; Wollny et al., 2021). In addition to imparting learning content, PCAs can serve as time managers (Gubareva & Lopes, 2020), provide emotional support to learners in a mentoring role to facilitate learning (Ranjbartabar & Richards, 2018; Wambsganss et al., 2020), or stimulate motivation using game elements (Benner et al., 2022). According to current literature reviews, the PCA 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). Striking examples are the PCA "*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) as well as ChatGPT as a disruptive technology (Kasneci et al., 2023). At the same time, a trend is emerging for conversational agents to become virtual companions that act with a long-term orientation (Nißen et al., 2021; Siemon et al., 2022; Skjuve et al., 2021; Strohmann et al., 2022). Sometimes, as in the case of "*Replika*", they even establish a friendship-like bond 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). VLCs promote frequent, intuitive conversations, enable collaboration (in terms of pooling skills and knowledge towards a learning goal), and thus form a suitable foundation for accompanying students in learning (Strohmann et al., 2022). However, the existing PCA literature does not 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, their study revealed a lack of design knowledge for PCAs, 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 those focused on the VLC approach. This finding is consistent with the results of other literature reviews (Hobert & Meyer von Wolff, 2019; Schlimbach, Rinn, et al., 2022).

2.2 Kernel Theories Determining Our Understanding of Learning with VLCs

The core idea behind our companionship approach is to enable the VLC to act as a collaborative partner fostering social interactions. We thus 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 et al., 1994). CASA theory has been widely spread to explain the human-like design of conversational agents (e.g., Elshan & Ebel, 2020; Feine et al., 2019; Seymour et al., 2018). For instance, incorporating social cues into conversational agents (human-like elements such as emojis or jokes) encourages users' social behaviors and results in positive perception (Demeure et al., 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 designing conversational agents, but it becomes even more crucial for the intention of social companionship (Krämer et al., 2011; Strohmann et al., 2022). Stressing the relevance of a bonding relationship corresponds well to common ground theory (Clark, 1992), which we incorporate thus as a second kernel theory into our design approach. The common ground theory is elementary in human-machine interaction, as pointed out by many researchers (e.g., Rothwell et al., 2021; Strohmann et al., 2022; Tolzin & Janson, 2023). This theory states that when communication partners establish a common understanding, a basis for a fruitful and collaborative conversation is growing (Clark, 1992; Clark, 1996; Koulouri et al., 2016) and applies to non-human interaction partners (in this case, the VLC and the user) as well (Elshan & Ebel, 2020;

Strohmann et al., 2022). Since our paper particularly focuses on supporting working students through VLCs, it is important that learners feel both motivated by our approach to learn and to apply what they have learned in their jobs, since success and growth on the job serve as essential factors for job satisfaction and motivation according to Herzberg (1966).

Traditional teaching approaches that transfer knowledge from the teacher to students do not leverage the learners' full potential because they lack students' engagement and often fail to challenge them (i.e., in motivating themselves and managing their time) (Behr et al., 2021; Lehmann et al., 2015; Rinn et al., 2022). Researchers emphasize that learning in the age of rapid digitalization needs to enable learners to develop competencies on their own and thus counteract these challenges (Abcouwer et al., 2022; Finster & Robra-Bissantz, 2020; Takács et al., 2022). Hence, our understanding of learning does not only include how to foster imparting knowledge like it is typical for PCAs (e.g., Hobert & Meyer von Wolff, 2019) but instead goes further toward a collaboration between humans and machines that strives toward developing competencies and metacognitive learning (Stowers et al., 2021). In the context of this paper, we understand (technology-mediated) learning as an opportunity for learners to grow and enhance their skills. In this sense, learners are empowered to achieve their growth aspirations (i.e., their higher-order needs according to the theory of needs fulfillment by Maslow (1943), later extended by Alderfer (1969) and McLeod (2007, 2020)). To achieve these higher-order needs, our VLC approach builds upon Maslow's kernel theory. We center our artifacts around collaboration between humans and machines, as the VLC explores learning content with the student and sparks curiosity to target cognitive needs while also showing appreciation for joint learning *(aesthetic needs)* and empowering the student for personal growth by reflecting on shared goals *(self-actualization)* (Abcouwer et al., 2022; Alderfer, 1969).

Furthermore, we incorporate validated kernel theories from education and motivation when designing VLCs to ensure rigor and match our RQ (Gregor & Hevner, 2013). 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. The flow theory justifies why people, in our case explicitly learners, are motivated to engage in an activity (Csikszentmihalyi, 1975, 1997). The flow theory defines various conditions for learners to enter a flow state (i.e., that they have clear goals, receive feedback on their activities to enable them to grow, and are neither under- nor over-challenged) (Csikszentmihalyi, 1975, 1997). A VLC applies these mechanisms to motivate learners to engage in positive behavior (e.g., by providing challengeable tasks and helping students develop shared goals together (Benner et al., 2022; Schlimbach, Windolf, et al., 2023)). To trigger flow effects, VLC designers can use persuasive design elements, for instance, game elements to incentivize reward and progress such as points and progress bars, as well as digital nudges that subtly encourage positive behavior such as reminders (Benner et al., 2021, 2022; Hassan et al., 2019; Khosrawi-Rad et al., 2023). In addition, learners are motivated to grow and improve themselves when their needs for competence, autonomy, and relatedness are fulfilled according to the self-determination theory (Ryan & Deci, 2000). Research has shown that self-determination theory can serve as a kernel theory to design conversational agents, as we briefly explain in the following and later pick up when deriving our design knowledge (Lechler et al., 2019; Yang & Aurisicchio, 2021). Designers can, for instance, address learners' need for competence when learners are rewarded for success and see that their achievements lead to positive performance. VLCs also contribute to fulfilling learners' aspirations for autonomy by encouraging learners to make their own decisions regarding their learning process and interaction. VLC designers must address students' need for enhanced relatedness, for instance, through social communication between VLC and learners. It is the synergy of all the mentioned kernel theories that makes a VLC possible, one that establishes a bond on the relational level, aligns with students' needs, provides motivation, and facilitates collaborative learning.

2.3 Complementary Theories for the Design of Virtual Learning Companions

Our emphasis on companionship traces its roots to Thorndike's (1920) concept of 'social intelligence.' The social interaction with the VLC is meant to build up self-awareness, self-management, social awareness, and relationship management to contribute to emotional intelligence, thus, the ability to perceive, utilize, and regulate emotions within oneself and others (Boyatzis et al., 2000; Salovey & Mayer, 1990). Furthermore, according to the theory of interpersonal trust (Rotter, 1980), conversational agents should promote the building of trust by users in order to be accepted in the long run (Schlimbach, Khosrawi-Rad, et al., 2022; Strohmann et al., 2022; Wambsganss et al., 2021). Learner engagement with supportive material can range from passive to active and constructive to interactive, according to Chi and Wylie's (2014) ICAP framework (an acronym for interactive, constructive, active, and passive). Rising levels of engagement across the four modes improve learning outcomes. Active engagement (e.g., by answering quiz questions) involves students actively addressing the learning subject, as opposed to passive engagement, when students passively absorb or receive the learning material (e.g., listening to a lecture). In the two most evolved modes, students reflect and transfer content reciprocally in the group through interactive engagement, while deepening their learning process by, for instance, comparing the learning material with their prior knowledge (constructive engagement) or even discussing it with others (teachers or peers). In line with the ICAP framework, facilitating interactions with the VLC through collaborative dialogue as well as with peers benefits learning at the highest engagement level (Chi & Wylie, 2014; Winkler & Roos, 2019). Overall, building upon the kernel theories from 2.2 and further concepts mentioned here, we aim to encourage learners to grow and develop themselves, encouraged by collaboration with the VLC.

2.4 A Value-driven Perspective on the Design of Virtual Learning Companions

The concept of value co-creation, which emphasizes collaborative and reciprocal value creation between actors and entities through mutually advantageous resource integration, is an important aspect when designing valuable interactions between a virtual companion and its human user (Blaschke et al., 2019; Schlimbach, Windolf, et al., 2023; Schüritz et al., 2019). Blaschke et al. (2019) suggest incorporating design expertise to support the construction of digital value co-creation networks enabled by service thinking. In contrast to a product-dominant perspective, service-dominant logic (Vargo & Lusch, 2008) considers services as the foundation for economic exchange (Lin et al., 2015). Service-dominant logic prioritizes *'value-in-use'* over *'value-in-exchange'* (Azkan et al., 2020; Vargo & Lusch, 2008). Value-in-use refers to the subjectively perceived value obtained from using a product or service, prioritizing the user's needs. In contrast, value-in-exchange focuses on the monetary value assigned to a product or service during a transaction (Vargo & Lusch, 2004). This perspective suggests that a VLC's value is defined by the student's individual perception of added value that is mutually created in the interaction with the learning purpose in mind (Schlimbach, Windolf, et al., 2023; Schüritz et al., 2019; Vargo & Lusch, 2004). Interaction is essential to co-create value (Geiger et al., 2020). According to the value-in-interaction model from Geiger et al. (2020), the value-in-interaction decomposes to the *value in relatedness* (on the relationship layer), *the matching value* (on the matching layer) and the *service value* (on the service layer) as illustrated in Figure 1. We follow the suggestion by Schlimbach et al. (2023) to use this model as a foundation for designing VLCs, as it encourages a more holistic and value-centered view on motivational and time-managing VLCs instead of staying at a mainly functional level that considers the VLC primarily as a product to be designed.

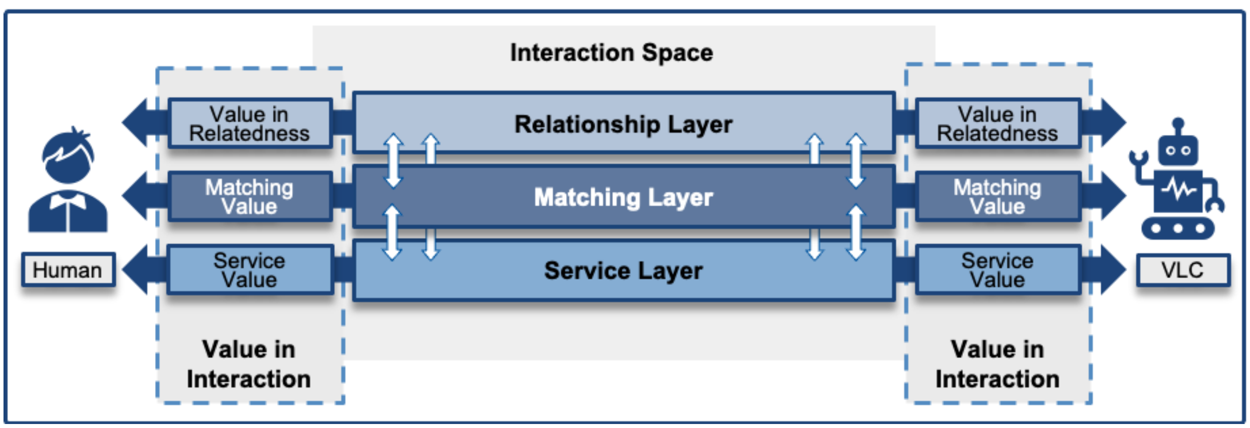


Figure 1. The Value-in-Interaction Model (Adapted from: Geiger et al. (2020))

In the value-in-interaction model, all three levels within the interaction space (a physical or virtual room where the interaction occurs; in this case a chat room) and their resulting values are interconnected and impact one another. To achieve meaningful interactions and develop worthwhile, valued interactions (in collaborative learning), actors in a service system must be able to exhibit competencies at all three tiers in parallel (Geiger et al., 2021; Schlimbach, Windolf, et al., 2023). The value-in-interaction includes collaboration and social competencies *(relationship layer)*, adaptation skills *(matching layer)*, and the provision of useful services to facilitate learning *(service layer)* (Geiger et al., 2020). Otherwise, if the VLC interaction is not perceived as beneficial by its human user, it will harm value co-creation, also known as value co-destruction (Li & Tuunanen, 2022). The latter causes service beneficiaries to be negatively affected (Fyrberg & Jüriado, 2009; Grönroos, 2011) or the chatbot to fail in terms of discontinued usage (Janssen et al., 2021). This unconventional perspective on deriving design knowledge along the three value-in-interaction layers implies that aspects supposedly unrelated to learning facilitation, such as social bonding or matching the student's preferences in the conversation, must be considered to foster successful learning with the VLC at its core.

3 Methodology

3.1 Design Science Research

For deriving design knowledge, we follow the Design Science Research (DSR) paradigm as an established approach to designing new and innovative artifacts while ensuring practical relevance and scientific rigor (Hevner et al., 2004). In DSR, the process model of Kuechler and Vaishnavi (2008) is an established framework we apply by conducting several iterative steps during artifact development.

In the **first design cycle,** we applied a co-creation approach and actively involved students from the target group in the VLC design (Abras et al., 2004). In the context of a four-month course, different teams of master's students majoring in technology-oriented management participated in our DSR project. During the course, the students had to design VLCs in a user-centered way (i.e., they collected the requirements of their fellow students, analyzed them, and created possible prototypes). Two authors of the paper continuously accompanied the students, introducing the concept of the VLC at the beginning of the course, and accompanied them throughout the semester. They received close scientific guidance from us, which enabled them to ensure rigor in VLC design. However, the course instructors emphasized that the students should set their own foci when planning empirical studies and designing prototypes. We also decided to let the students choose the RQ of the DSR projects on their own, and during the course, the students identified motivation and time management as their main problems, for which they wished a VLC to support them. We actively involved the students, as they could be future users and could thus consider the topic of VLC design through the lens of their own needs. 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 (team 1 & team 2) 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 (team 3) conducted a systematic literature review to explore the status quo in needs, requirements, and design knowledge for PCAs in general as a supportive literature to derive the final design knowledge (Möller et al., 2020). Team 1 and team 2 visualized their results in a mapping diagram of USs, MRs, and DPs (Möller et al., 2020). 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*" and "*Botsociety*," respectively. To evaluate the design knowledge, team 1 conducted a user test for the instantiation (ex-post *evaluation*), whereas team 2'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, 9 DPs, and 33 categories of DFs.

In the **third design cycle**, we programmed a VLC by instantiating our derived design knowledge. We conducted a digital creative workshop with students from the target group following the design thinking phases *(empathize, define, ideate, prototype, test)* by Brown (2008). Design thinking made the participating students empathize with the problem statement and allowed us to incorporate previous results. Participants included three master's students who had been working for several months on a research assignment on VLCs, a master's student in software engineering, and four working students majoring in technology-management. During the workshop, we jointly prioritized DFs for VLC implementation, ensuring they were desirable, feasible, and viable. We also defined the technical architecture for VLC implementation and discussed the concrete implementation of the prioritized DFs. Over the course of three months, the design and evaluation of the prototype were intricately intertwined. In bi-weekly meetings, multiple researchers, educators from three educational institutions, and individual representatives from the target audience engaged in discussions about the implementation progress. During these sessions, they tested some features derived from the design knowledge and scrutinized it from various perspectives. In this dynamic setting, the prototype underwent gradual and multi-perspective refinement. After this three-month iterative development phase, we validated the prototype in user tests and subsequent evaluation workshops. We conducted a study with 20 full-time students from a public university (*ex-post validation 1*) and in a second context with 14 working part-time further education students of vocational training *(ex-post validation 2)* (Venable et al., 2016). These tests allowed us to gather comprehensive feedback from the target group covering two different study models.

Figure 2 illustrates the DSR procedure by mapping the three DSR cycles into the framework of Kuechler and Vaishnavi (2008). The procedure of the individual studies is explained in more detail below.

	First design cycles (DC1.1 & DC1.2)		**Second design cycle (DC2)**		**Third design cycle (DC3)**
Awareness of Problem	User interviews & literature review		Reflection of DC1		Design thinking workshop with students
Suggestion	User stories, kernel theories, meta-requirements and design principles		Refinement and synthesis to a final set of design knowledge		Set of selected design features for planned instantiation
Development	Two conceptual prototypes of a Virtual Learning Companion		Derivation of design features for guiding future instantiations		Fully coded Virtual Learning Companion "Alex"
Evaluation	User test	Interdisciplinary workshop	Focus group discussion	Expert interviews	User test & survey in two educational institutions
Conclusion	Meaningfulness of design knowledge with a greater need to reduce complexity		Design knowledge is applicable and perceived positively		Design knowledge is useful for real-world application

Figure 2. DSR Procedure (According to: Kuechler and Vaishnavi (2008))

3.2 The Procedure of the Individual Studies

3.2.1 Literature Review

We included five databases from the fields of information systems, computer science, business, and education. The search term consisted of expressions for conversational agents (e.g., "*chatbot*") combined with synonyms for requirements (e.g., "*study requirement*"), prescriptive recommendations (e.g., "*design principle*"), or features (e.g., "*design feature*"). Initially, we identified 424 hits from the 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 et al., 2010). Finally, we selected 48 publications for full-text analysis, which we clustered along with the virtual companion canvas (Strohmann & Robra-Bissantz, 2020). The virtual companion canvas is a design tool created by Strohmann and Robra-Bissantz (2020) for planning the design of virtual companions. It helps designers and developers plan the creation of a virtual companion conceptually before technically implementing it. It contains the following dimensions: Humanoid design (representation of the virtual companion, audiovisual characteristics, emotions, and personality), Communication (natural language understanding and intuitive conversations), interaction (autonomy, proactivity, and context-awareness), collaborative environment (trust, benevolence, and ethical code), as well as collaborative human-machine interaction (relatedness, adoption, common goal, and reciprocity). Further researchers already applied the virtual companion canvas in different contexts (e.g., for designing a virtual companion for meditation applications) (Simon et al., 2021). We excluded studies that either did not contribute design knowledge or were unrelated to education.

Figure 3 depicts the literature review procedure.

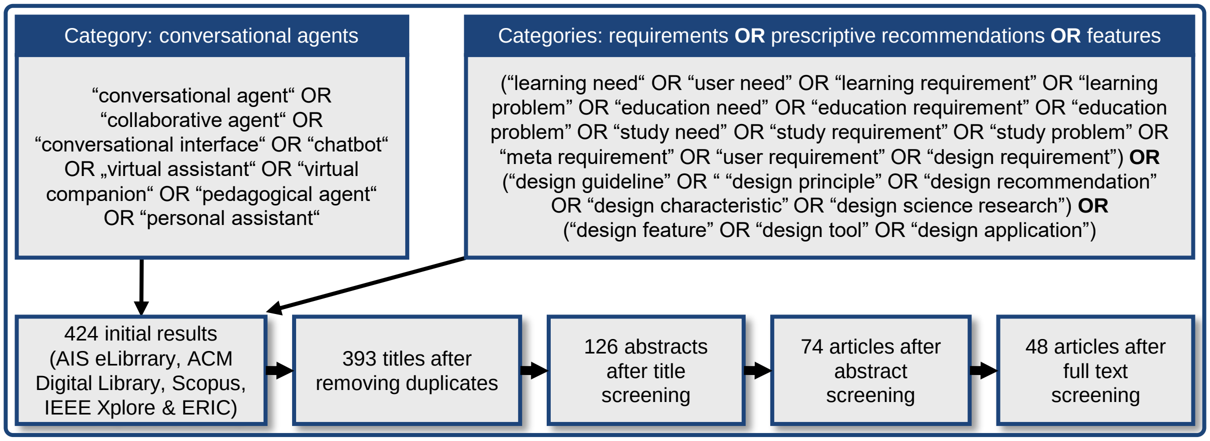


Figure 3. Literature Review Procedure

In this paper, we assigned the results from the literature review to the individual categories of the virtual companion canvas via post-its. We used the findings and kernel theories as supporting literature to strengthen the design knowledge.

3.2.2 Interviews for Needs Assessment and Evaluation of the Conceptual Prototypes

A total of 14 semi-structured interviews were conducted with working students from German universities (six by team 1, and eight by team 2). All participants were part- or full-time professionals in parallel to their studies. The interview guides possessed a focus on existing student challenges with time management and motivation (*problem space*) and elicitation of desires and DFs for VLCs (*solution space*) (vom Brocke et al., 2020). We fully transcribed and coded all interviews using "*MAXQDA*." Team 1 used inductive coding, according to Mayring (2015), so the codes emerged while reviewing the data. Team 1 chose to use inductive coding because this approach allowed us to analyze the material neutrally, in a subject-oriented manner, and without bias of prior theoretical assumptions (Mayring, 2015). The coding scheme was divided into the main areas "*students' initial situation*" and "*design of the VLC*" and twelve subsequent categories. In total, team 1 assigned 499 codings, and we then formulated USs based on these results. The USs were combined with literature findings to form MRs, leading to DPs. Team 2 used deductive coding based on a pre-established labeling guide, which follows the structure of the interview guide. Team 2 chose to use deductive coding to align the analysis with the interview guide questions and thus provide a good match to the objective of the VLC design (fostering learning motivation and time management) (Mayring, 2015). Thereby, 28 code categories and 287 labels were assigned. We first categorized the results and then also formulated overarching MRs and DPs. We deliberately chose to use different coding approaches in data analysis within both teams to demonstrate that different research methods can also lead to the formation of condensed requirements of actual users and to reduce the overall bias in the research approach.

To evaluate the results of team 1, we conducted an online study in which the prototype designed based on the tentative 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*' (SUS) (Brooke, 1996). Our study involved 40 potential future users (learners) who watched a video demonstrating the prototype. We surveyed university students who work more than 20 hours a week in addition to their studies to address the target group of working students. We presented the individual features of the prototype and a sample dialog to the students using the software 'Maze' for online surveys and gave them the task of evaluating the prototype afterward. The whole evaluation procedure lasted approximately 15 minutes.

We discussed the results of team 2 in a workshop in which, in addition to the authors of this paper, 9 other participants (lecturers/researchers, students, and developers) attended and evaluated the results from their respective roles in small groups. The group discussion lasted approximately 90 minutes and the participants had the task of providing comments on the design of the VLC in the form of post-its as well as discussing the effectiveness of the design knowledge. The three groups were each guided by workshop facilitators. To assess 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 and VLC 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 a *Miro* whiteboard by adding post-its. We recorded, transcribed, and analyzed the interviews which lasted 90 – 120 minutes. Although the experts did not introduce additional DPs, they expressed supplemental MRs and DFs (e.g., adaptability of the VLC personality for DP2 or features for exchanging learning materials among peers for DP7).

Figure 4 illustrates the procedure of the conducted interview studies (DC = Design Cycle; I = Interviewee).

	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 (I10), Research Associate (I11), Junior Researcher (I12), Scrum Master (I13) & Co-op Student (I14)	Educational Software Development (I15-I17), 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. 20-35 minutes	Approx. 90-120 minutes

Figure 4. Procedure of Interview Studies

3.2.3 Design and Evaluation of the Coded VLC

We have chosen the design thinking (DT) approach as a suitable methodology for generating implementation strategies for DFs detailed in co-creation with the target group and experts in VLC design and development. As Brown (2008) points out, DT is a creative problem-solving approach that is particularly suitable for interdisciplinary teams to develop innovative and user-centered products and services. DT aims to bring together diverse experiences and perspectives on a problem (Redlich et al., 2018) and is suitable for creating a prototype (Vogel et al., 2021). Besides, DT is a recognized controlled mindset for creative problem-solving (Lewrick et al., 2021; Schenk et al., 2022) widely used to develop human-centered solutions (i.e., in information systems design) (Vogel et al., 2021). We started by gathering the research results on a digital whiteboard, creating a persona to empathize with the problem, and detailing the mapping diagram with our design knowledge. Participants collected keywords related to the DPs in pairs in the first creative round and associated them with corresponding design features and underlying needs. Resulting ideas for DF implementation were then presented across teams. Next, two teams of four students each further detailed the emerging ideas and specified those into DFs, with the software developer considering technical feasibility. We used the VC canvas by Strohmann and Robra-Bissantz (2020) to map our prioritized feature set onto the canvas and assigned these to the corresponding DPs.

We validated the practical feasibility of the VLC's programming based on the DFs we provided. In the two evaluation workshops, we had the students interact with the instantiated VLC on their devices in class. The prototype emphasized the transmission of time management strategies and a friendly-motivational communication approach to address the identified problem areas of poor time management and lack of motivation with the concept of companionship. We discussed the students' experiences and overall impressions regarding the two main concepts of our RQ (motivation and time management) as well as students' perceptions regarding the companionship approach of our VLC. We collected their feedback on the implemented DFs, in that we discussed how those facilitated or hindered their motivation, time management, and companionship with the LC. Due to our value-centered focus (see section 2.4), we were interested in their perception of the relationship to the VLC *(relationship layer)*, whether their needs in learning facilitation are met *(matching layer),* and discussed potential areas for improving the VLC's functionality *(service layer)* (Schlimbach, Windolf, et al., 2023). We then discussed their perceptions by category (see section 4.3.3, Results).

4 Results

In the following, we present the results of the individual studies in a condensed form. For transparency, the interim 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.

Our design knowledge encompasses all three layers of the value-in-interaction model (Geiger et al., 2021), which are closely intertwined, as explained in section 2.4. Therefore, the DPs cannot be mutually exclusively assigned to a single layer but create value through their interplay. Figures 5 and 6 illustrate our final set of 9 DP aligned with corresponding meta-requirements (MRs) and design features (DFs). The color scheme inherits the tone of the value layer it primarily mirrors, although being complemented by aspects from all layers involved. Interim results on design cycles 1 and 2 and more details on each DP will be further specified in the following sections.

Our DPs cover a holistic view of collaborative learning leveraged by growth needs (Abcouwer et al., 2022) and go thus beyond the concepts of time management and motivation. DP1, DP3, and DP4 significantly contribute to the relationship value by emphasizing the concept of companionship. Therefore, they are closely linked to the DP for virtual companionship introduced by Strohmann et al. (2022). We see DP2 intertwined because it represents the adaptation at the core and, together with individualized features, generates a positive matching value. The VLC's customization (Schlimbach, Rinn, et al., 2022) and adaptivity (Plass & Pawar, 2020) leverage personalized learning. The service value is mainly enabled by DP5-DP9, which promotes motivation and time management as functional elements in learning facilitation. Nevertheless, our value-centered perspective regards corresponding features close to the more social and educational aspects of the VLC (Benner et al., 2022) and the interplay of all value layers.

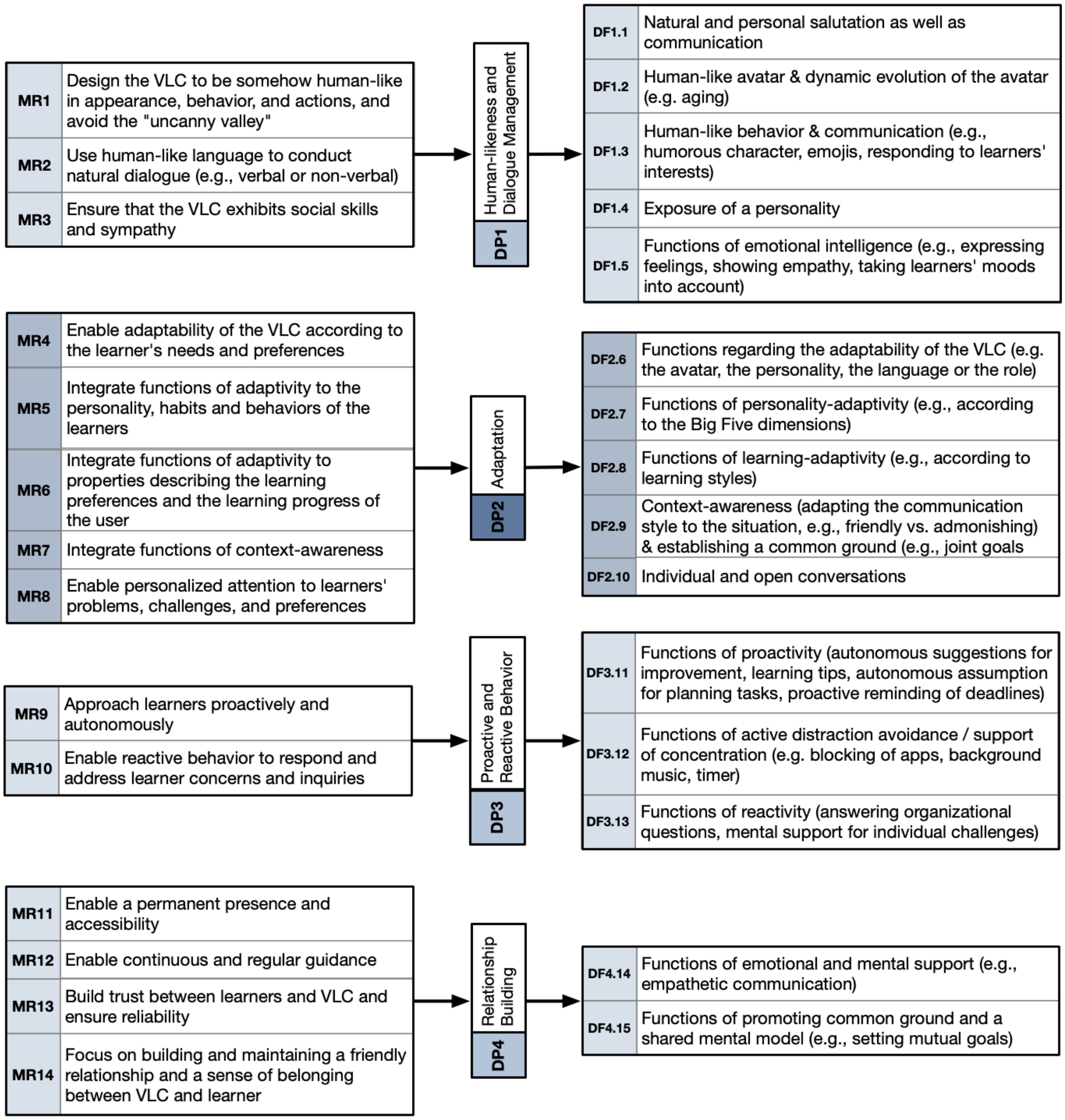


Figure 5. Mapping Diagram Part I

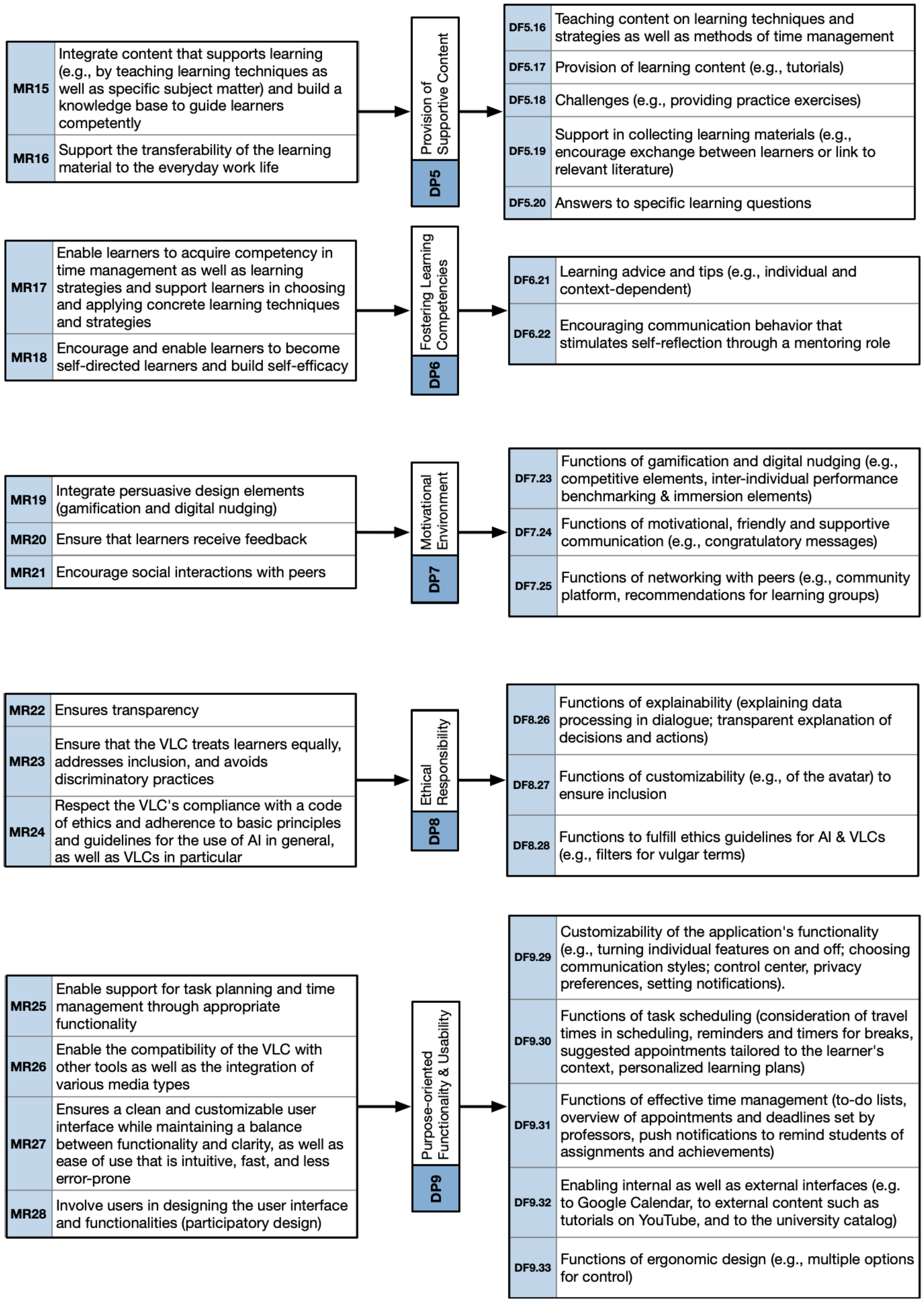


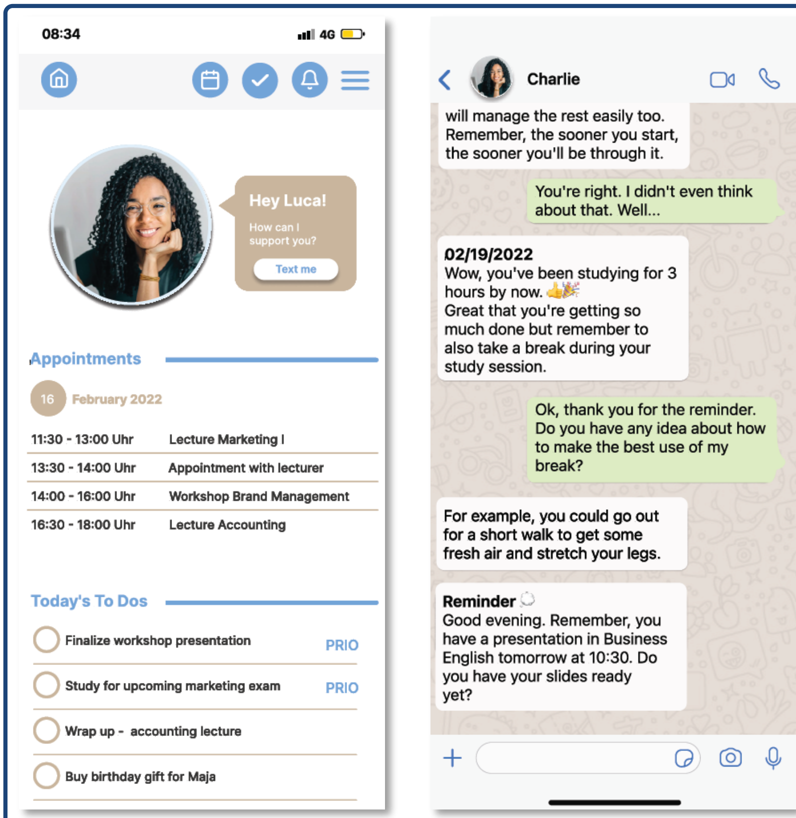
Figure 6. Mapping Diagram Part II

4.1 Design Cycle 1: Initial Design Knowledge

4.1.1 Design Cycle 1.1

Based on 40 USs as well as 39 MRs, we formulated 13 initially resulting DPs with the following foci: *Human-likeness, friendship and relationship, VLC behavior* (proactive and reactive, motivating, self-acting, as well as persistent presence), *customization and adaptivity, transparency and privacy, functionality* (scheduling, task planning, skill building, learning support), and *user interface (UI) and usability*. To illustrate these, we instantiated a human-like VLC mock-up as a clickable design dummy. We named the VLC "*Charlie*" and used the design tool "*Virtual Companion Canvas*" by Strohmann and 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 features (e.g., to-do lists and calendar view).

The results of the evaluation (fulfillment of the DP foci measured on a 5-point Likert scale and system usability scale) are summarized in Figure 7 (depicting the respective mean values (MV) and standard deviations (SD) complemented by two selected screenshots of the designed prototype, covering time scheduling features in the app with, for example, a prioritized to-do list and a time table with appointments (left screenshot) and an exemplary conversation, in which the VLC Charlie gives its human user advice on mindful learning and chats about ideas on what to do in the study break to increase motivation through self-actualization (center screenshot) (Abcouwer et al., 2022).



Design Categories	
Human-likeness	MV: 3.10 SD: 1.26
Friendship & Relationship	MV: 3.50 SD: 1.23
Behavior	MV: 3.80 SD: 1.23
Adaptability & Adaptivity	MV: 3.60 SD: 1.06
Quality (Functioning & UI)	MV: 4.20 SD: 0.69
Usability	
SUS	81.75 (out of 100) *Brooke, 1996*
Key Data on the Survey	
Scale: 1 = Strongly disagree; …; 5 = Strongly agree; Participants: 40 (Mean Age: 27) with 93 % Part-time Students and 7 % Dual Students	

Figure 7. Evaluation Results of Charlie

Overall, the prototype was evaluated mostly positively, with particularly high MVs on the functional scope and UI as students praised the supportive feature set and appealing interface. We see potential for improvement in the categories *human likeness, friendship and relationship* as well, which might arise from the fact that the respondents did not interact with a mature product. Higher SDs in these categories indicate heterogenous perceptions on Charlie's social characteristics and might relate to affinity bias or varying individual preferences of the evaluating students. In addition, respondents suggested additional features (e.g., gamification and push notifications) that we considered for design cycle 2.

4.1.2 Design Cycle 1.2

Based on 30 USs and 30 MRs, we derived 10 DPs. The first five 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 and language, proactivity, (personal) data protection and accessibility, and relatedness*. In addition, we derived five DPs explicitly applicable to the learning context, which relate to *knowledge and motivation* (provision of learning content, motivational environment) and *functional properties* (task planning support, effective time management, compatibility and feasibility). Team 2 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 advice counteracts the idea of the VLC as a coequal partner (Strohmann et al., 2022)).

4.2 Design Cycle 2: Derived Design Principles and Design Features

In this section, we elaborate on the conclusively derived 9 DPs and 33 DFs. We introduce each DP with its underlying theories and mechanisms in the following subsections. Our overarching concept always implicates virtual companionship as the basis for fruitful collaboration in learning between the VLC and interacting students.

Time management and motivation play significant roles in collaborative learning, so we incorporate them into the design concept of VLCs in a holistic and value-oriented manner. We establish detailed connections between the kernel theories and these foci (motivation and time management) by elaborating on the derived DPs in the following sub-sections. Since for each DP, the implementers (VLC developers), users (learners), and the context (interaction between VLC and working students) are identical, we do not repeat it in Tables 1-9 for clarity. Further details on the design knowledge (e.g., screenshots of the conceptual prototypes) are available in the digital appendix: https://bit.ly/3z6xzI5.

4.2.1 DP1: Human-likeness and Dialogue Management

First, we identified a human-like design of the VLC as crucial to promoting learners' trust and relatedness to the VLC (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 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 overly-human-like (Strohmann et al., 2022).

Consequently, we recommend the VLC's design be somewhat 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 et al., 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 and the user's mood, like *Replika* does) (Skjuve et al., 2021). Research shows that the emotional behavior of a VLC positively affects learning outcomes and its social presence, leading to an overall motivational interaction (Chatzara et al., 2010, 2016; Qin et al., 2020).

Table 1 depicts our resulting DP1 of Human-likeness and Dialogue Management.

Table 1. DP1 of Human-likeness and Dialogue Management

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.

4.2.2 DP2: Adaptation

The interviews revealed the high individuality of learners' needs and habits, as they have different learning preferences and need for personalized learning techniques and strategies (Dağ & Geçer, 2009; Dunlosky et al., 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 buddy). Preferences in the degree of power distance in the relationship between VLC and learner significantly depend on students' cultural background (Schlimbach & Zhu, 2023).

We propose DP2 of Adaptation in Table 2, which is further detailed below.

Table 2. DP2 of Adaptation

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 his/her 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.

In terms of adaptivity, the VLC might adapt to the user's personality (Ahmad et al., 2022) (e.g., along the "*Big Five*" model (McCrae & John, 1992)) by customizing features depending on the student's openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. It should 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 considering 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 et al., 2021) as well as to the learner's mood (Diederich et al., 2019). To do so, the VLC might be both friendly and 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). Especially motivational drivers to learn vary between six archetypes depending on how the respective students prioritize relatedness, purpose, mastery, extrinsic reward, autonomy, and change and thus require adaptation (e.g., by rewarding achievers with points and badges), while students primarily driven by relatedness require more social features like a group chat or a common challenge (Steinherr & Reinelt, 2022).

4.2.3 DP3: Proactive and Reactive Behavior

While many conversational agents 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 et al., 2019). To enable the benefits of a long-term virtual companionship that motivates to learn and facilitates time management by spending time more effectively on collaborative learning with the VLC, the latter should exhibit both proactive and reactive communication (Winkler & Roos, 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 major distraction causing concentration problems for learning, consistent with recent literature (Rinn et al., 2022). 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, reactive behavior is also required to support learners' upcoming individual concerns and inquiries (Winkler & Roos, 2019) (MR10).

Thus, we propose DP3 of Proactive and Reactive Behavior (Table 3).

Table 3. DP3 of Proactive and Reactive Behavior

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.

4.2.4 DP4: Relationship Building

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 provide personalized support and continuous and regular guidance (MR12) since continuity positively affects learning progress (Dunlosky et al., 2013). Moreover, building a personal relationship with a conversational agent requires long-term use as a prerequisite for trust building and reliability (Nißen et al., 2021; Savin-Baden et al., 2015; Strohmann et al., 2022) (MR13). As a byproduct, recurrent use facilitates the collection of interaction and learner data, thereby enhancing the quality of support provided by the VLC (Janssen et al., 2021). Like *'Replika'*, a personalized AI chatbot that forms a social connection with its human user and mimics authentic human interaction, a VLC should also communicate empathetically to provide emotional and mental support (Elshan & Ebel, 2020; Savin-Baden et al., 2015; Schlimbach, Khosrawi-Rad, et al., 2022).

The VLC should promote the establishment and maintenance of a friendly relationship as well as a sense of belonging (MR14). Research shows that perceived relatedness toward the VLC is motivating (Baylor et al., 2005; Silvervarg et al., 2014). Such a sense of relatedness arises from a common ground between VLC and learners (Elshan & Ebel, 2020; Strohmann et al., 2022) (i.e., when den VLC empathizes with the mental perspective of its human counterpart) (Clark, 1992; Krämer et al., 2011). For that purpose, VLCs use shared conversational styles, show mutual understanding, or set common goals (e.g., a team slogan or a learning goal that students and VLC cooperatively work towards) (Clark, 1996; Clark & Brennan, 1991; Tolzin & Janson, 2023). These mechanisms lead to a shared mental model between the VLC and its human partner (Elshan & Ebel, 2020; Mathieu et al., 2017; Strohmann & Robra-Bissantz, 2020). The shared mental model contributes to co-create a value in relatedness (Schlimbach, Windolf, et al., 2023) and inspires growth aspirations as introduced by McLeod (2007, 2020).

Thus, we propose DP4 of Relationship Building (Table 4).

Table 4. DP4 of Relationship Building

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.

4.2.5 DP5: Provision of Supportive Content

To foster students' personal growth in long-term usage of the VLC, the interviewed students and experts emphasized that content facilitating self-actualization (e.g., recommended learning techniques or subject-related resources) should be integrated into the VLC continuously (MR15). Thus, a solid knowledge base is necessary so that learners perceive the VLC as a friend and a competent learning facilitator. Since several interviewees found it difficult to apply the learning content to their jobs, highlighting its practical relevance is crucial to demonstrate the purpose behind it as a critical motivational driver (Steinherr & Reinelt, 2022) (MR16). On the service layer, this involves conveying content, sharing a learning goal to work towards, as well as answering specific questions via dialogue to reap the benefits of interactive learning according to the ICAP framework (Chi & Wylie, 2014).

In doing so, the VLC should address the students' growth needs, like sparking curiosity for the learning content or empowering self-actualization, when sharing strategies on how to realize personal potential and self-fulfillment in learning (Abcouwer et al., 2022). To balance aesthetic needs (Abcouwer et al., 2022), the VLC should balance internal and 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) while also forming mindful learning habits (Schlimbach, Windolf, et al., 2023). Since the target group perceives the organization of learning materials as challenging, especially due to the lack of time alongside their jobs, they expressed the desire to be supported in compiling learning materials effectively, (e.g., by providing references to relevant literature or opportunities to share learning materials).

Thus, we propose DP5 regarding the Provision of Supportive Content (Table 5).

Table 5. DP5 Regarding the Provision of Supportive Content

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.

4.2.6 DP6: Fostering Learning Competencies

Furthermore, according to self-determination theory, the development of users' individual study skills leads to higher self-confidence in terms of their competence and staying motivated (Lechler et al., 2019; Ryan & Deci, 2000) as well as perceiving that they are responsible for their 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 having 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 by encouraging them to autonomous learning to overcome challenges on their own (experience self-efficacy)) (Wollny et al., 2021) (MR18). To promote self-efficacy, the VLC could, for example, 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 (Table 6) that go far beyond the transfer of knowledge as students develop new skills and strategies for learning in collaboration with the VLC.

Table 6. DP6 Regarding the Fostering of Learning Competencies

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.

4.2.7 DP7: Motivational Engagement

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 et al., 2021, 2022). Game elements represent elements that have been transferred from games to non-gamified areas (learning with VLCs), such as reward elements (e.g., points or badges), progress elements (e.g., progress bars or levels), or other elements such as game stories (Benner et al., 2022, p. 202; Deterding et al., 2011; Khosrawi-Rad et al., 2023). Digital nudging refers to small and subtle design adjustments that encourage users to behave in a certain way, such as reminders (Acquisti, 2009; Benner et al., 2021;

Hassan et al., 2019). These design elements promote fun in learning (Benner et al., 2022) and encourage the emergence of flow effects (Csikszentmihalyi, 1975). Furthermore, they promote the perception of competence (Lechler et al., 2019; Ryan & Deci, 2000). For instance, 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 forming and interconnecting learning groups) (Wang et al., 2020). This mechanism is relevant because many respondents considered the (pandemic-enforced) lack of contact with fellow students as a key challenge. At the same time, interactive learning along the ICAP framework favors strong learning outcomes (Chi & Wylie, 2014).

We propose DP7 of a Motivational Environment (Table 7).

Table 7. DP7 of Motivational Environment

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.

4.2.8 DP8: Ethical Responsibility

Furthermore, the ethical considerations in VLC design are crucial (Schlimbach, Khosrawi-Rad, et al., 2022) because ethics reflect social norms and form the basis for shared ethical values in collaborative learning. For students to trust the VLC, transparency is relevant (MR22) so that they 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 must treat learners equally and avoid discriminatory bias (Schlimbach, Khosrawi-Rad, et al., 2022; Wambsganss et al., 2021) (MR23). Bias might otherwise result in value co-destruction (Li & Tuunanen, 2022). Thus, 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, racist, or sexist expressions) (Casas-Roma & Conesa, 2021; Han et al., 2021; Schlimbach, Khosrawi-Rad, et al., 2022; Wambsganss et al., 2021). Students need to be aware that in the collaborative learning approach, they are mutually responsible for shaping future interactions as the VLC constantly learns from their input. For instance, the chatbot *"Microsoft Tay"* learned vulgar terms from its users which led to its discontinuation.

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). Furthermore, the VLC should allow learners to freely customize the avatar (gender, ethnicity), as stereotypical design may discriminate against users and deconstruct value through (unconscious) bias (Schlimbach & Robra-Bissantz, 2022). Inclusive VLC design is also meaningful (e.g., providing voice control as a feature for blind people) (Schlimbach, Khosrawi-Rad, et al., 2022). Thus, we propose DP8 of Ethical Responsibility (Table 8).

Table 8. DP8 of Ethical Responsibility

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.

4.2.9 DP9: Purpose-oriented Functionality and Usability

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). To enable 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. Following Schlimbach et al. (2023), we regard time management as a multifaceted impediment that must be addressed by an appropriate feature set like mitigating procrastination while also generating relatedness and matching value to secure the technologies' adoption (van der Zandt et al., 2021). 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 and external interfaces is essential (e.g., connecting to Google Calendar for scheduling support or 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 et al., 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), and thus enable more autonomy for the student as the self-determination theory suggests. Finally, in the spirit of participatory design, users should be actively involved in the design from early on (MR28) through a co-creation processes, including iterative evaluations (Abras et al., 2004). Following these considerations, we propose DP9 of Purpose-oriented Functionality and Usability (Table 9).

Table 9. DP9 of Purpose-oriented Functionality and Usability

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.

4.3 Design Cycle 3: VLC Instantiation as a Coded Prototype

In this section, we introduce an instantiated text-based VLC prototype that we designed and coded based on the design knowledge introduced in previous sections. The VLC is named "*Alex*" and aims to provide students in higher education with personalized and interactive support in their time management and motivate them to learn. We explore the prototype's architecture, features, and capabilities and demonstrate how it assists learners in their educational journey by evaluating it with students from two different educational institutions.

4.3.1 Architecture

The implemented architecture for the instantiated VLC involves using Google Dialogflow to handle assigned intents with dynamic task execution. When a desired action is identified (technically an assigned intent), Dialogflow sends requests with information about the assigned intent to a webhook service. A webhook is a simple way to connect different web services without complying with specific interface requirements for each application separately. Therefore, webhooks can be regarded as a ubiquitous communication interface that facilitates the integration of various services, web applications, and mobile applications without necessitating the need to adhere to individual API requirements for each service. To connect to a database (login) and make external API services usable (such as Google Calendar), we built a webhook server with the programming language Python. The local webhook server can receive calls from Dialogflow, and process and return them. For a dynamic response, the VLC then calls on external services (such as Google Calendar) through API commands or accesses an implemented database. There is previous knowledge in using an SQL database accessed through a structured query language (SQL) database. Since our webhook processes encrypted requests (https), opening a tunnel on the local machine that can also process these requests on the internet through the ngrok application from Google Cloud is necessary.

With this architecture implementation, the VLC can handle dynamic requests to provide natural language responses to its human users, as depicted in the following Figure 8.

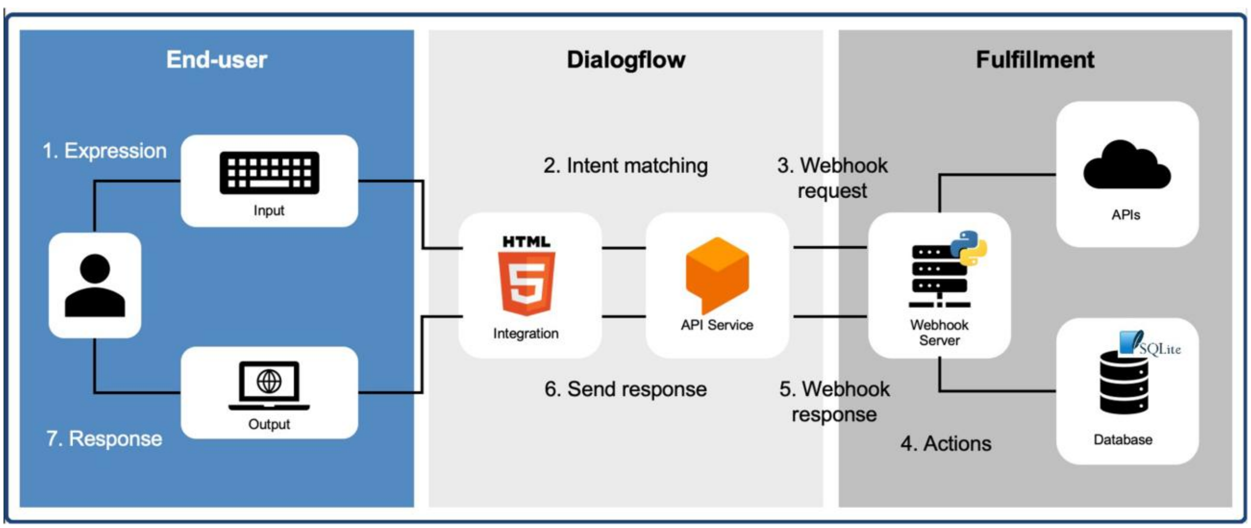


Figure 8. VLC Architecture

Regarding the knowledge base and intents Alex can respond to, we fed the VLC with a sample course unit on user experience design and exemplary learning content that includes learning strategies for improved time management, such as the Pomodoro technique that splits each learning activity into focus phases followed by mandatory breaks to improve the learning efficiency (Almalki et al., 2020). However, Alex's focus lies in learning support features such as motivational communication to finish a learning unit or organizing study sessions and breaks that are potentially applicable to any learning unit. For that reason, we spent more time training Alex on these accompanying functionalities and its design centered around the three value layers rather than on the learning unit's technical terms (that serve just as sample learning content).

4.3.2 Design Features for the Coded VLC

In the final design cycle for this study, we implemented a fully coded VLC and modified some of the proposed DFs to better suit our specific use case of supporting working students (aged in their 20s) conducting further education. Four exemplary screenshots A-D highlight some implemented features in Figure 9.

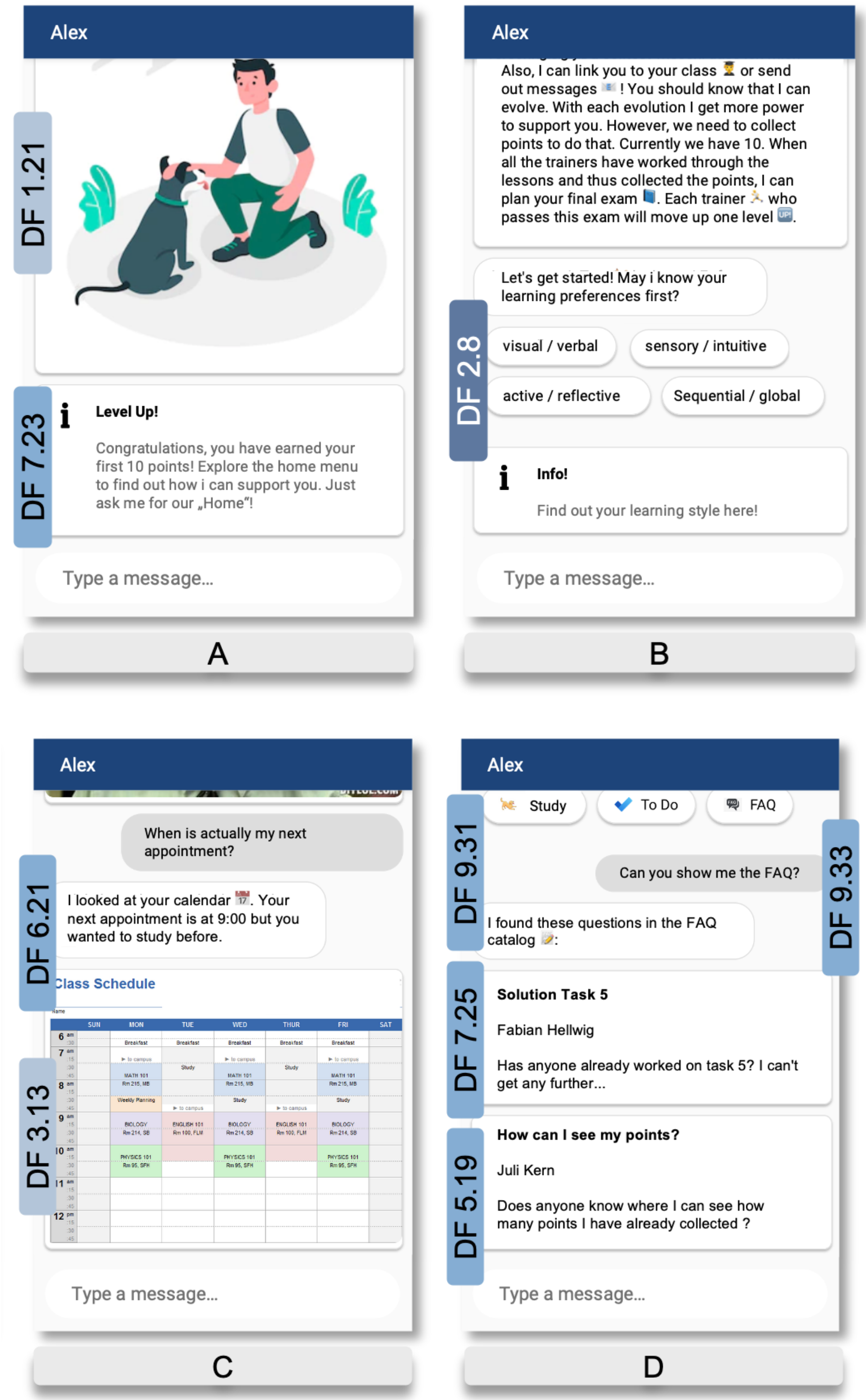


Figure 9. Sample Screenshots of the VLC

Our customization of some DF is based on the understanding that design principles for IT-based artifacts, as discussed by Gregor et al. (2020), are often generic and non-deterministic. The authors argue that users may utilize the artifact differently than initially anticipated by the design principles. Therefore, the mechanisms of a design principle should aim to achieve a goal while considering the potential variations in user behavior (Gregor et al., 2020). Consequently, we adapted the selected DFs to accommodate these considerations and to align with the study's objectives. We ensured that all DPs were represented by aligned DFs that we picked based on a discussion with researchers, designers, and the software developer on their expected viability, (technical) feasibility, and contribution to designing the three value layers (see section 2.4) for bonding interactions with the VLC (Schlimbach, Windolf, et al., 2023).

Table 10 summarizes the before mentioned specifications of implemented DFs in VLC Alex.

Table 10. Specification of DFs implemented in the Prototype

DF#	Description of DF Implementation in VLC Alex
DF1.1	A registration procedure involving database connection (name, date of birth, email, course, username, password, learning style, level) is utilized to greet users by their first name.
DF1.2	The LC icon is designed as a human-like avatar, and congratulatory pictures are displayed as the avatar levels up.
DF1.3	Additionally, emojis, humorous pictures, GIFs, and memes are used to uplift the mood.
DF2.8	The learning style is adaptive according to Felder and Silvermann's model.
DF2.10	Open conversations are handled by intent-matching on a webhook.
DF3.13	The course schedule shows upcoming lectures and the module plan for each lecture, with a focus on promoting mental health and well-being through reminders to drink water, exercise, or take a walk.
DF4.15	A scoring model for the entire class is implemented, fostering a common ground with the chatbot and classmates.
DF5.16	Various learning techniques, such as the Pomodoro technique, are explained.
DF5.18	Certain features are accessible only at higher levels but are still visible, such as initiating a "session" for live chatting with all online classmates.
DF5.19	The learning material is organized and provided in course content, to which the user is directed when learning begins. Additionally, users learn from each other through public FAQ.
DF6.21	A communication pathway is established to understand learning issues and provide recommendations based on them.
DF7.23	Gamification game mechanics, such as levels, quests, missions, avatar, and points, are incorporated.
DF7.24	Level-up message and user-specific points acting as motivational triggers.
DF7.25	Networking functionalities are provided through an online FAQ, direct messages, and group sessions.
DF8.26	Privacy consent in the onboarding process.
DF8.28	A socio-culturally inclusive avatar is utilized.
DF9.31	Each user can create, manage and edit a personalized todo list.
DF9.32	In-chat emails can be sent to classmates or teachers.
DF9.33	Buttons and open-conversation-Intents with a so-called "home-menu".

On the relationship layer (Geiger et al., 2020), Alex establishes a close bond with the learner from early on through personal salutation and self-referencing as a collaborating student, addressing students by their first name based on the registration data provided (DF1.1). We designed a youthful avatar in a human-like comic style for Alex (DF1.2), who moves naturally and is accompanied by a dog that can learn tricks when the student accomplishes a learning goal (see Screenshot A) and thus shows appreciation for making progress (competence gain as a motivational driver from self-determination theory). Together with the use of emojis, humorous memes (DF1.3; see Screenshot B), and positive messages celebrating jointly achieved goals (DF4.15; Screenshot A), we aim to create a strong bond (Strohmann et al., 2022). As depicted in screenshot B, Alex gives students the autonomy to align their respective learning preferences by adapting to the learning style (e.g., active vs. reflective) and media input (e.g., embedded video vs. text-based explanation) (DF2.8) (Felder & Silverman, 1988). The VLC strives to increase the matching value by catering to the learner's personal needs (e.g., reacting to individual schedules; screenshot C). The VLC's features assigned to the service layer strongly emphasize motivational aspects and support time management. In this regard, Alex emphasizes adhering to schedules (screenshot C) by sending push notifications and reminders for personalized to-do lists (DF9.31). Alex asks learners about their mental state, adjusts the learning pace and breaks, and provides relaxation exercises accordingly (DF3.13). In this regard, we follow the recommendation of Schlimbach et al. (2023) that VLCs should not push their users like machines to increase efficiency but should promote mindful use of resources instead. Therefore, Alex also counteracts cognitive overload (Mayer & Moreno, 2003) by limiting the use of multimedia content (DF9.32) and supporting ease of use through anchor points such as a clear home menu (DF9.33). Alex supports the learner's motivation through gamified features such as ascending to higher levels, leading to new development stages of the avatar, and learned tricks for the dog (DF7.23), accompanied by empowering level-up messages (DF7.24). Encouraging group chats with peers (DF7.25) or exchanging learning materials in the class should promote social interaction and thus motivation for exchange with peers (screenshot D). Alex facilitates independent digital learning while offering networking features that enable the exchange of chat messages with peers and teachers (DF9.32) for collaborative learning.

4.3.3 Evaluation Results of the Coded VLC

The implementation of VLC Alex has validated the practicality of our design knowledge by transferring it into a fully functional prototype. The different levels of abstraction mitigate the tension between clear orientation and sufficient leeway for implementation. For example, we chose the comic-like design of the avatar to appear human-like but not entirely human. Additionally, we introduced the emotionalizing component of the dog as a dynamically evolving companion, highlighting the freedom for concrete implementation of our proposed DPs – while this playful theme appears suitable to the target groups of working students in their early 20s, more mature professionals would probably require a different approach.

Table 11 on the next page summarizes the core results (top two ranked criteria per question as listed in the table’s footer) of the VLC’s ex-post validation at the two German educational institutions in comparison (van der Zandt et al., 2021). Students at the technical university (institution A) study full-time and are accustomed to large-scale lectures, mostly without professional experience. In contrast, students of the continuing education group (institution B) are employed and undertake (paid) further education in a classroom setting. Both cohorts integrated the VLC in a Business course and then provided detailed qualitative feedback in the 2-hour evaluation workshop.

The user evaluation revealed that students from both institutions particularly appreciated the human and friendly interaction with VLC Alex. They highlighted social cues (Seeger et al., 2018) at the verbal level, such as human-like response behavior, non-verbal cues like memes and gifs, and the positive impact of the human identity through avatar embodiment. From a user perspective, this feedback validates the significance of the VLC approach compared to the more prevalent use of chatbots as tutors in general (Khosrawi-Rad, Rinn, et al., 2022). Students welcome the VLC’s implementation in time managing and motivational roles (Chen et al., 2022; Du et al., 2021; Kimani et al., 2019) while also emphasizing social relatedness.

However, we also observed differences in the evaluation of the current implementation. While students from the public technical university perceived Alex's language style as too informal, stating that *"he uses too many colloquial terms,"* students from the continuing education institution found Alex *“too formal”* in the interaction instead. They wished for a more pronounced human identity through dynamic typing, mutual praise, and emotion-reactive behavior. Participants from the technical university, on the other hand, referred to the emotionalization with many emojis as *"childish"* and described their usage as *"a bit too much."* The technical university students consistently approved of gamified elements, stating that these motivated them to learn. In contrast, the gamified storyline itself was perceived as distracting by the further education students.

Both groups wished for feedback on the tasks accomplished, with the technical university students preferring shared achievements and messenger functions with peers and the other group preferring visible progress and rewards. Nevertheless, vivid discussions revealed that these motivational preferences, in accordance with other literature on motivational preferences (Tondello et al., 2016), are person-dependent leading to the necessity of adaptive and adaptable features (Schlimbach, Rinn, et al., 2022). While both groups attached great importance to Alex's assisting role in learning organization, enabled by to-do lists and reminders, additional desired features for the technical university students related more to interface expansion (e.g., linked content, quick reactions, and input extensions). Contrarily, further education students prioritized social-oriented features, such as empowering messages and fostering well-being when learning. Although both groups are comparable in their demographic characteristics, differences in the evaluation of Alex were observed. These differences could be attributed to the already demonstrated changing user expectations towards conversational AI in different contexts (van der Zandt et al., 2021).

Table 11. Results from the Qualitative Evaluation

		Institution A (public technical university) (n = 20)	Institution B (further education) (n = 14)
(A) Motivation	Q1	1. Human response behavior 2. Competitive gamification elements	1. Human response behavior 2. Empowering phrases
	Q2	1. Too many emojis 2. Repetitive fallbacks/default settings	1. User interface (i.e. dark colors) 2. Game-story
	Q3	1. Sharing achievements / chat history 2. Messenger functionality (1:1 with peers)	1. Feedback features (i.e. progress, rewards) 2. Personalized design of the interface
(B) Time Management	Q1	1. Organizer (e.g., a scheduling bot service) 2. Personalization (onboarding, home-menu)	1. Buttons that are easy to understand and use 2. Generation of a to-do list
	Q2	1. Non-cancelable intentions (to-do list, E-Mail) 2. (Technology) maturity	1. Tasks can be canceled before their fulfillment 2. Time spent on navigation and chatting
	Q3	1. Integrated, applied learning methods 2. Verbal interface	1. Automated reminders (goals, deadlines, etc.)
(C) Companion-ship	Q1	1. Anthropomorphic Design (gifs, emojis, memes) 2. Avatar embodiment	1. Human-like response behavior 2. Humor (memes and gifs)
	Q2	1. Informal language style (e.g., colloquial terms)	1. Formal language style 2. Lack of mutual praise
	Q3	1. Adapting language style to target group 2. Quick reactions	1. Stronger human identity 2. More profound reactions to the learner's mood

Q1: What was (A: motivational; B: supporting your time management; C: makeing you feel like interacting with a friend)?
Q2: What was rather discouraging?
Q3: Which additional design features might enhance your learning experience?

The evaluation has shown that contextual factors contribute to the different weighting of interaction value levels, for example, because the relationship and informal social interaction in the classroom setting of institution A play a higher role than at the technical university, where anonymous, formal learning regularly takes place in large cohorts with several hundred students. Overall, our evaluation shows that the instantiated VLC was well received by both groups and that all students claim to consider collaborating with Alex in learning in the long term. Nevertheless, it seems crucial to adapt the VLC's design to the target group's preferences (Schlimbach & Zhu, 2023). Once again, the user feedback underscores the importance of precisely aligning social features for perceived companionship (relationship layer) and the functional scope encompassing motivation and time management (service layer) to the target audience (matching layer) - only then do valuable VLC interactions emerge. As reflected by our software developer, DPs and exemplary DFs provide scope for interpretation and design to meet this demand.

5 Discussion

5.1 Implications for Research and Practice

Overall, our study contributes to a better understanding of how VLCs should be designed to promote learners' motivation and time management in higher education. Through three DSR cycles, we conducted interviews with working students and experts, held interdisciplinary workshops with the target group, designed and evaluated two conceptual prototypes, and fully coded a VLC instantiation, which we tested with students in two contexts (public technical university and further education provider). Our approach yielded 9 design principles, 28 meta-requirements, and 33 design features, which guide future **research** on VLCs along with thoroughly derived design knowledge at varying levels of abstraction (Möller et al., 2020).

Our research on VLCs is deeply rooted in established kernel theories, notably, the Computers are Social Actors Theory, which posits that humans exhibit human-like behavior toward computers by applying social norms to them (see section 2.2). This theory has been instrumental in explaining the human-like design of conversational agents and their perception as companions (Strohmann et al., 2022). Additionally, our approach is influenced by Maslow's hierarchy of needs, emphasizing the importance of addressing cognitive, aesthetic, and self-actualization needs in the learning process (Abcouwer et al., 2022). The flow theory by Csikszentmihalyi (1975, 1997) further reinforces our design principles, highlighting the conditions for learners to achieve a state of complete immersion and motivation – two major challenges that our target group, working students, continuously face when studying in further education programs (Rinn et al., 2022). By intertwining these theories, we have aimed to offer a comprehensive and innovative perspective on VLC design. Furthermore, our design contributions are contextualized and especially tailored to the learning environment of working students in further education but also address the nuances of different implementation and usage settings by highlighting adaptation as a connecting DP that bridges socially oriented DP on the relationship layer with the VLC's functional scope on the service layer (see section 2.4). This holistic approach applies the foundational theories and learning concepts providing actionable design knowledge tailored for VLCs on various abstraction levels (9 DPs, 28 MRs, 33 DFs, 2 conceptual instantiations, and 1 fully coded VLC prototype).

Moreover, we offer an unconventional, value-driven perspective on VLC design, in contrast to the traditional research focus on the functional scope of the VLC (Schlimbach, Windolf, et al., 2023). We view VLC interactions as a service in learning and emphasize the importance of considering the learner's perspective in designing these systems (Bovill, 2020). Our approach aims to foster bonding relationships between learners and their virtual companions to facilitate time management and motivation in collaborative learning based on common ground (Tolzin & Janson, 2023). In this regard, we see our VLC approach as a critical driver for collaborative learning that regards learning as a mutual process of interactive resource integration from learners towards a shared goal (Roberts, 2004; Tolzin & Janson, 2023). In other words: the learner is not fed with knowledge by the VLC but interacts with the VLC on learning topics and thus also integrates their own ideas and strategies for leveraging potential on the human side while also co-creating new insights for the VLC and its knowledge base when working together interactively – thus the highest level of engagement (Chi & Wylie, 2014).

At the same time, students and the VLC are mutually responsible for the fed-in data that shape (future) interactions and thus collaboratively shape value co-creation or co-destruction, respectively (Li & Tuunanen, 2022). By foregrounding value orientation in VLC design, we aim to encourage researchers and practitioners to consider the ethical implications of their designs and promote responsible, human-centered innovation for responsible AI in society (Floridi & Cowls, 2019). Our comprehensive study, encompassing interviews, interdisciplinary workshops, and the development of several VLC instantiations, has revealed pivotal insights for future VLC research. We have highlighted the importance of a value-centric perspective over a purely functional one, suggesting a deeper exploration of how learners perceive and interact with VLCs with the intention to holistically design valuable VLCs that facilitate learning as an accompanying long-term process. Our approach thus amalgamates previous research contributions that either focus on common ground and social aspects (Tolzin & Janson, 2023), or potential in adaptation (Schlimbach, Rinn, et al., 2022), or a mainly functional scope on motivation and time management features (e.g., Chen et al., 2022; Du et al., 2021). From this holistic perspective, the collaborative essence of learning, where both learners and VLCs jointly contribute to a learning objective, warrants further investigation, especially in contrasting educational settings and across different cultures, since recent studies indicate significant cultural differences in the perception of learning companionship (Schlimbach & Zhu, 2023). Overall, our findings underscore the vast potential for future research and practical applications, emphasizing the evolution of VLCs that are both advantageous and contextually situated in their design.

From a **practice** perspective, our study addresses the need for learning solutions that foster autonomy in learning, critical thinking, and self-actualization rather than reacting to prompts with fully elaborated solutions. While conversational agents such as ChatGPT have become increasingly popular, they can also pose a risk of causing users to rely on them without thoughtful consideration, potentially diminishing students' ability to think critically. In contrast, our approach aims to empower learners to collaborate with the VLC to promote active and engaged learning and, thus, deeper understanding and retention of knowledge (Chi & Wylie, 2014; Krathwohl, 2002). The rise in publications on pedagogical conversational agents, as well as advances in AI, suggest 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). In this course, we see VLCs as a vehicle to support, rather than replace, human teaching and learning.

Moreover, with the idea of companionship between students and conversational AI in mind, we also aim to promote ethically responsible interactions. This thought includes raising awareness of potential ethical considerations such as bias, privacy, and the risk of students becoming overly reliant on technology (Schlimbach & Khosrawi-Rad, 2022). For instance, studies have shown that conversational agents can perpetuate existing biases if their training data and design are not carefully selected and curated (e.g., Fossa & Sucameli, 2022; Moran, 2021). Additionally, the use of such technology may raise concerns about privacy and data protection, and it is vital for designers and users alike to be mindful of these issues. Ultimately, by focusing on value-orientation and bonding relationships in VLC design, we strive to inspire practitioners to think open-mindedly about how VLCs can facilitate learning without compromising the value co-creation that underpins effective and future-oriented education.

5.2 Reflecting Critically on Our Contribution

However, the implementation of our design knowledge for VLCs in practice was not without controversy. For example, the participants of the evaluation studies discussed individual aspects of design knowledge disputatiously along with the DSR cycles. For instance, 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 conversational agents 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 previous 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 suggest highlighting 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 a more inclusive product and to support as many learners as possible. For example, 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 these 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 (such as personalized appointment suggestions, timers, and 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. However, recent research argues for bringing these seemingly opposing aspects together in that human companions also act in different roles depending on the situation (Schlimbach, Windolf, et al., 2023). Since the range of supportive features as well as VLC roles demonstrate its versatility, adaptability proves crucial again. Customization also includes settings to deactivate functions (e.g., if a learner does not want personalized appointment suggestions based on the fed-in data, and empowers the feeling of autonomy as a key motivational driver) (Schlimbach, Behne, et al., 2023). However, it's essential to note that while customization offers learners the flexibility to tailor their VLC experience, deselecting certain features might reduce the overall utility and effectiveness of the VLC. It's crucial for designers to strike a balance, ensuring that core functionalities remain intact while allowing for personalization.

Furthermore, the interviewees discussed the technological implementation critically. Regarding the integration of the VLC into existing infrastructures, I15-17 proposes 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 reactions (e.g., deducted from sentiment analysis) might be prone to errors to then potentially harm the interaction and destruct value instead of co-creating it (Li & Tuunanen, 2022).

Since the categories of DFs currently offer a lot of design freedom for implementing a VLC, the design team ultimately needs to decide which DFs fit best in each application context (van der Zandt et al., 2021). Our VLC instantiation Alex exemplified situation specific perceived value in that the students' evaluation coming from a vocational training context differed regarding their perception and improvement ideas for Alex compared to the university students' feedback in some respects. Although challenging, conversational design constantly evolves making creating and continuously adapting VLCs easier (e.g., using building platforms like "*Google Dialogflow*") (Diederich et al., 2019). Adopting a value-oriented perspective across the three layers of value-in-interaction (Geiger et al., 2020) can facilitate a more nuanced weighting of design elements based on context parameters like time horizon (Nißen et al., 2022), usage purpose (Følstad et al., 2019), or learning cultures (Schlimbach & Zhu, 2023), as these can be either a barrier or leverage for the adoption of an information system (VLC Alex) (Roberts et al., 2023). To this end, our proposed design knowledge is meant to be a theoretical foundation for designing innovative learning support artifacts (Gregor et al., 2020; Hevner et al., 2004).

5.3 Limitations

This article has strived to shape valuable collaboration between humans and intelligent machines in the educational context by providing prescriptive design knowledge for VLCs. However, we admit some limitations: First, the evaluation of existing design knowledge has so far relied primarily on expert views, the results of an online study, and real interactions with the instantiated VLC in a class setting rather than evaluating emerging companionship over the long term. Second, the subjective influence of respondents, as well as researchers in deriving design aspects, cannot be ruled out due to the co-creation process. We have taken steps to mitigate these limitations: We derived the design knowledge both by consulting students (user-centered design) and the existing knowledge base and to reduce bias, we derived and refined it in several iterations by researchers working independently of each other before reflecting and merging the results. Additionally, while our research aimed to be inclusive, we recognize the importance of considering equality, equity, diversity, and inclusion in VLC design. The prevention of bias, especially in the context of diverse user groups from various cultural backgrounds, is crucial. We admit that further research is needed to ensure that our VLC design caters to a wide variety of users, respecting their unique backgrounds and needs. We thus suggest that our design knowledge should be tested and evaluated in further contexts and discussed together with other researcher and practitioners and their experiences.

5.4 Research Agenda

Building upon the insights and findings of our study, there is a rich avenue for future research to further explore and refine the design and application of VLCs. Our study has highlighted the importance of considering diverse learner demographics and cultural nuances. As technology and educational paradigms evolve, it is crucial to investigate how VLCs can be designed to cater to a broader spectrum of learners from varied cultural and socio-economic backgrounds. Furthermore, the kernel theories adopted in our study provide a foundation that future research can build upon, either to confirm or extend these theories in different contexts. Another promising area is the exploration of VLCs in different learning environments, such as remote or blended learning, informal learning settings, or specific student groups. The rapid advancements in conversational AI also open doors for research into newer bot modalities and their implications for education. Lastly, as our study has emphasized the non-deterministic nature of design knowledge, it would be beneficial for future studies to further consider iterative design approaches, continuously involving different target groups (i.e., professors and the value VLC might create for them in facilitating coursework). This research agenda aims to foster dialogue in the domain and encourage researchers to push the boundaries of what is possible with VLCs in education.

6 Conclusion

In conclusion, our research sought to address the question of how to design Virtual Learning Companions (VLCs) that effectively facilitate learning, particularly regarding time management and motivation, from a value-oriented perspective. Through an iterative Design Science Research approach in three cycles, we conducted interviews, interdisciplinary workshops, and evaluations, leading to the derivation of 9 design principles, 28 meta-requirements, and 33 design features for VLCs (see section 4, Figures 5 and 6). We revealed that supporting students in their time management and increasing their motivation to study requires following a holistic approach, including bonding relationships for collaborative learning with the VLC and the interplay of three value layers (relationship, matching, service) in mind. Furthermore, the evaluation of a coded prototype in two educational institutions confirms that students' feedback differs based on context (Følstad et al., 2019). For that reason, our prescriptive design knowledge should be modified to the given usage purpose when being reused to account for its non-deterministic nature (Gregor et al., 2020). Potential next steps include further development by continuously involving the target group before implementing a more mature prototype to be tested in a longitudinal study. In a controlled field experiment, we strive to measure the impact of the VLC on the students' motivation, time management, and ultimately their learning performance and to also discuss the perceived value in interacting with Alex. Finally, as the field of conversational AI in education continues to evolve, we are eager to see how our design knowledge might contribute to VLC design in other cultures, usage contexts, and bot modalities to then learn from the insights and experiences of other researchers and practitioners in this rapidly expanding research domain.

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Susanne Robra-Bissantz has been head of the Institute for Business Information Systems and the Chair for Service Information Systems at Technische Universität Braunschweig since 2007. She actively works on new forms of teaching like GamEducation or Flipped Classroom concepts and has implemented numerous third-party-funded projects in cooperation with industry. Her work on eServices, Collaboration Technology, eLearning, and context-aware Information Systems has been published in international conferences and recognized journals.