Design Principles for Gamified Pedagogical Conversational Agents

Bijan Khosrawi-Rad
Technische Universität Braunschweig
b.khosrawi-rad@tu-braunschweig.de

Arne Borchers
Technische Universität Braunschweig
arne.borchers@tu-braunschweig.de

Linda Grogorick
Technische Universität Braunschweig
l.grogorick@tu-braunschweig.de

Susanne Robra-Bissantz
Technische Universität Braunschweig
s.robra-bissantz@tu-braunschweig.de

ABSTRACT

Pedagogical conversational agents (PCAs) such as chatbots and voice assistants can support learners in their studies. However, interactions with PCAs are often perceived as less motivating. Gamifying PCAs has been proposed as one approach to counteract this issue and increase learners' engagement. However, there is currently little prescriptive knowledge on how to design gamified PCAs. To address this, we conducted interviews with learners and reviewed relevant literature to derive 18 meta-requirements, five design principles, and 20 design features for gamified PCAs. We then applied our design knowledge to create a conceptual prototype, which we validated through an experiment with 76 participants. The experiment results demonstrate that our design knowledge can positively influence motivation and enjoyment in learning with PCAs.

CCS CONCEPTS

• **Applied computing**; • **Education**; • **Interactive learning environments**; • **Computing methodologies**; • **Natural language processing**;

KEYWORDS

Pedagogical Conversational Agent, Gamification, Education, Design Principle

ACM Reference Format:
Bijan Khosrawi-Rad, Arne Borchers, Linda Grogorick, and Susanne Robra-Bissantz. 2023. Design Principles for Gamified Pedagogical Conversational Agents. In *26th International Academic Mindtrek Conference (Mindtrek '23), October 03–06, 2023, Tampere, Finland*. ACM, New York, NY, USA, 16 pages. https://doi.org/10.1145/3616961.3616973

1 INTRODUCTION

Learners have difficulties in motivating themselves to learn [73, 84, 114]. Digital technologies can be used by higher educational institutions to motivate learners and promote their learning success. One of these technologies are pedagogical conversational agents (PCAs), i.e., intelligent dialog systems that aim to support learners by interacting with them using natural language options such as text or voice [45]. This allows them to guide learners individually [117]. They can, for instance, teach learners content through dialog, help them manage their time, motivate and mentor them, or encourage collaborative group work [54, 117]. However, many PCAs are inadequately designed and thus rejected by their users [34, 48]. In particular, interactions with PCAs are often not very stimulating, so that they cannot fulfill their potential of motivational support [12, 98]. This leads to learners discontinuing the PCA use [ibid.]. Gamifying PCAs has been proposed as one way to counteract this issue [12]. Gamification has been showing positive learning effects for years, such as promoting engagement [97] or knowledge gain through quizzes and challenges [92]. Studies also determined that gamification is a critical success factor for long-term PCA use [78, 102]. However, researchers emphasize that in order to achieve positive effects through gamification, it is vital to design gamified systems adequately [97]. If gamified learning applications are not adequately designed, this can lead to negative consequences such as competitive pressure or frustration [42, 107]. Designing gamification appropriately is a complex and difficult process, esecially due to the large number of possible design options [91, 97]. Accordingly, providing designers with recommendations for the creation of gamified PCAs is crucial. Researchers already contributed frameworks for gamified systems in general [e.g., 21,85,86,97], but frameworks that apply gamification in conversational systems such as PCAs are rare [53]. Since the effects of gamification can vary in different contexts and application systems [42], it is useful to establish prescriptive recommendations for gamified PCAs. Benner et al. [12], for instance, provide a first approach to establishing design knowledge by contributing a conceptual framework for gamifying PCAs. However, this framework still lacks the formulation of design principles (DPs), i.e., prescriptive rules for a proposed design [37]. These DPs would be useful to guide researchers and practitioners in designing innovative artifacts [38]. We address this research gap with the following **research question (RQ):** How to design gamified PCAs in order to foster students' motivation to learn?

We focus on motivational empowerment because recent studies show that learners particularly desire technology support in term of motivation [10, 84] and because gamification can address this issue by boosting learners' motivation [23, 65]. Researchers have highlighted that higher motivation leads to learners acknowledging the value of the PCA and consequently being more willing to use it regularly [83, 95]. Consequently, we contribute knowledge to

Mindtrek '23, October 03–06, 2023, Tampere, Finland

ACM ISBN 979-8-4007-0874-9/23/10.
https://doi.org/10.1145/3616961.3616973

solving the initially described problem of PCA rejection. To answer our RQ, we derive design knowledge for PCAs based on interviews and kernel theories, illustrate it in a low-fidelity prototype, and evaluate it in an experiment.

2 RESEARCH BACKGROUND

2.1 Gamified Pedagogical Conversational Agents

PCAs interact with humans using natural language, either as chatbots or as voice assistants [45]. PCAs are popular in digital education because they are always accessible, can support learners in their learning processes by giving advice, and enable human-like interactions [45, 113]. In addition, continuous progress in artificial intelligence (AI) enables PCAs to understand their users' concerns better and respond to them [27]. Therefore, PCAs are increasingly able to build relationships with their users by acting as virtual companions [78, 103]. Furthermore, PCAs can take on different roles to support learners depending on their functions and behaviors [12, 54, 117]. For instance, they can act as a tutor by teaching knowledge, as motivators by encouraging learners to study, as mentors by accompanying their learning progress, as organizers by assisting them in everyday study tasks, or as moderators by facilitating group work [54]. However, interactions with PCAs are often less stimulating [12]. Gamification can counteract learners' low engagement because game elements motivate users during their activities and foster long-term engagement [8, 25]. We speak of gamified PCAs when PCAs are enriched with individual game elements [12, 53]. For example, Benner et al. [11, 12] developed the PCA "Micromate" to foster learners' motivation with rewards or progress visualizations. Overall, different game elements can be used to achieve motivational effects. Schöbel et al. [12] provide a taxonomy of game elements already applied in the context of PCAs. Accordingly, the following game elements can be used in PCAs for motivational purposes: points, badges, virtual goods, level, ranking, progress bar, feedback/information, avatar, goals, time pressure, narratives, and reminder. We use this taxonomy in this paper to align our proposed design of gamified PCAs with it.

2.2 Kernel Theories for the Design of Gamified Pedagogical Conversational Agents

We incorporate scientific "kernel theories" from the disciplines of motivation, learning, and human-computer interaction (HCI) to rigorously design our artifact [38, 72]. In the following, we will explain the reasons why we include theories from these different disciplines. We include motivational theories because we found in a recent PCA literature review that many of the existing PCAs are insufficiently designed based on motivational theories, which could be a reason why many do not reach their full potential [54]. In this paper, we focus on motivation as the key variable of the design science research project and use gamification as an approach to enhance motivation, which is why we include motivational theories that are established in the gamification literature. However, since our literature review revealed that PCAs should be designed in an interdisciplinary manner, we add learning and HCI theories that are already established in the PCA context [ibid.]. In that way, we aim to provide a broad theoretical basis for the holistic design of gamified PCAs. Furthermore, we aim to contribute knowledge for the design of PCAs that addresses both self-regulated learning (independently determining the learning process) [123] and social learning (learning in a group, collaboratively and competitively) [7] as recommended by researchers [36]. This allows us to show how gamified PCAs can be applied in different learning contexts. In the following paragraphs, we will explain each of the kernel theories.

We rely on the self-determination theory (SDT), according to which motivation arises from fulfilling human needs of competence, autonomy, and social relatedness [89]. Game elements should, for instance, encourage learners' competence through rewards, provide learners with the opportunity to make autonomous decisions, and promote social relatedness through collaborative learning [89, 91]. Moreover, we incorporate flow theory, which suggests that being fully immersed in an activity facilitates learning [24]. Furthermore, we consider the ARCS model, which defines different motivational factors, such as providing challenges or that learners perceive the content to be relevant [52]. In addition, learners should be able to pursue specific goals and receive feedback regarding their goals [62, 64]. This leads to positive learning outcomes according to goal-setting theory [62, 64]. In addition, we consider helping learners gain confidence in their ability to manage challenges on their own (self-efficacy) [6]. Self-efficacy can be fostered by regularly applying learning content (e.g., in quizzes) [109]. Furthermore, we use the social comparison theory, according to which people strive for comparison with others at a similar ability level [33]. Consequently, this should be considered when integrating competitive elements to avoid negative consequences such as frustration [61, 91, 101]. Rewards should also be equitable so that, according to equity theory, there is a balance between the performance and the reward received to avoid frustration [1, 93].

In terms of applying learning theories, the PCA could provide learners with tasks having different levels of difficulty (e.g., remembering and applying) to address both lower and higher levels of learning goals according to Bloom's taxonomy [4, 12, 13]. In this regard, according to the ICAP framework, it is also crucial that learners not only passively absorb content but that the PCA fosters constructive and interactive learning [19]. The PCA can take this into account both by assuming the role of a learning partner as well as by encouraging interaction with fellow students [19, 44, 112]. To support learners, the PCA should provide assistance while maintaining a "zone of proximal development." For instance, the learning tasks should slightly exceed the ability level of the learner [111]. In this way, learners can progress and receive step-by-step assistance in solving the challenges through hints by the PCA (so-called "scaffolding") [115, 116, 119]. In addition, repetition is vital to process the content actively, and repetition intervals should become progressively longer following the "spacing effect" [16, 87].

Regarding the HCI, the PCA should act somehow human-like to foster users' trust according to the computers are social actors (CASA) theory [75]. According to social agency theory, the PCA can take a specific human-like role (cf. Chapter 2.1), so interaction with the PCA can be made more instructive if it is interpreted as social communication [12, 66].

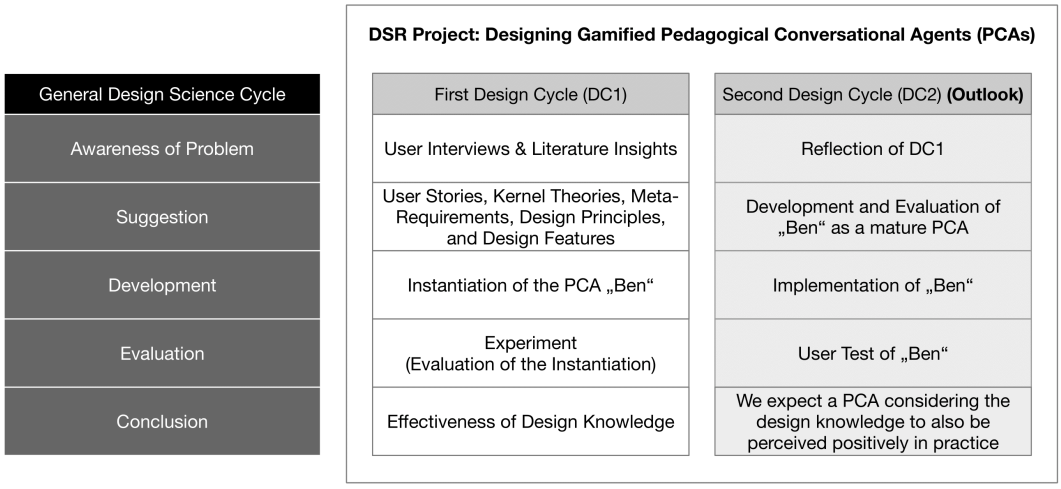

Figure 1: Design Science Research Procedure

3 METHODOLOGY

We follow the design science research framework by Kuechler and Vaishnavi [60]. This framework has several sequential steps to systematically derive design knowledge, starting from the awareness of the problem to the proposal of the design knowledge, its implementation, and the conclusion about the findings (see Figure 1). In this paper, we report the results of our first design cycle. We used this framework as it is process-oriented and thus allowed for a step-by-step research procedure [60], and because design science researchers have repeatedly emphasized that this is an established model for deriving design knowledge [e.g., 9,38,104].

First, we interviewed eight potential PCA users (four male and four female) to get aware of the problem space and gain insights regarding the solution space [15]. For this purpose, we used a semi-structured interview guide (see Appendix A.1) [105]. We mainly asked questions regarding problems and challenges in learning and desired solutions for the gamified PCA. Regarding the PCA design, we included questions about motivating as well as demotivating functions and behaviors of the PCA, the preferred roles of the PCA (cf. Chapter 2.1), and the implementation of the individual game elements according to the taxonomy by Schöbel et al. [97]. We analyzed the interviews qualitatively [67]. For instance, we created a coding guide for the two superordinate categories. The further sub-categories emerged inductively, and we finalized our coding in a revision cycle [67]. Based on the results, we subsequently formed user stories (USs) according to the scheme described by Moser [74] and assigned them to the associated game elements. We complemented the results with the kernel theories (cf. Chapter 2.2) and supporting literature on gamification and education when deriving the DPs [71]. Based on the synthesized findings from interviews and literature, we formulated meta-requirements (MRs), DPs, and design features (DFs). According to Möller et al. [71], we visualized them in a mapping diagram. We formulated all DPs using a unified schema, according to Gregor et al. [37], consisting of the goal, implementer, user, context, mechanisms to fulfill the DP and rationale. Since PCAs can take different roles and consequently show different functions [12, 54, 117], we specified the PCA role in the "context" part of each DP. We illustrated all DPs in a conceptual prototype, "Ben," to instantiate our design knowledge [38]. To evaluate our DPs, we formulated testable propositions (TPs) that corresponded to the objectives of each DP and which can be measured by constructs [39]. We evaluated each DP by validating our TPs regarding whether learners perceive our expository instantiation in compliance with the DPs to be better than a baseline artifact that does not consider the DPs [110]. In the next design cycle following this paper, we develop Ben as a mature PCA and test it with real users (see Figure 1).

4 DERIVATION OF DESIGN PRINCIPLES

In the following, we will elaborate on the five DPs. Since the implementer is identical for each DP (PCA designer), we do not repeat this information in the formulation of each DP. The corresponding USs are visible in the Appendix A.2 and the mapping diagram is visible in the Appendix A.3.

The participants expressed that visualizing the learning progress helps to be able to evaluate one's own skills and knowledge (US1). According to goal-setting theory, this feedback positively affects learners' performance [62, 64]. Consequently, a gamified PCA should visualize learning progress to highlight learners' achievements (MR1). In addition, the learners wished to get rewards when they achieve special outcomes (US2). These rewards should take into account the time and work needed to succeed. For instance, learners should receive special rewards if they reach long-term milestones and fulfill complex tasks (US3) [32]. Rewarding learners increases their perception of competence [89, 91]. Rewards provide learners with feedback on their positive performance, and when they are awarded performance-related, it encourages learners' motivation [90]. Hence, the PCA should reward positive performance (MR2) and use different game elements for this purpose, considering the students' work effort (MR3). To implement the MRs, the PCA could consistently award points for correct answers and accomplishments (DF1), distribute virtual goods such as coins for medium-term

DP1: Performance-Related Motivation	
Aim and User	To design a gamified PCA that **motivates students, guides them in their learning process,** and thus **encourages their perception of competence**,
Context	design the PCA as a **motivator** that rewards students and visualizes their progress.
Mechanisms	Therefore, the PCA should: • constantly reward learners with points for correct answers and positive achievements • grant virtual goods for medium-term achievements and milestones • give badges for achieving major achievements and milestones, which can be collected in an awards overview • visualize learning progress using progress bars that are based on points and goals achieved • provide information about the achievement of a level, which increases based on the points earned. Furthermore, these levels should exist for each subject area of a course.
Rationale	Users wish to be informed about their learning progress at different levels. They also aim to be rewarded when they reach certain milestones. According to goal-setting theory and flow theory, the feedback received via rewards could positively impact on learners, increasing their overall perception of competence. Thus, the PCA could positively influence learners' motivation according to the self-determination theory.

Figure 2: DP1 regarding the Performance-Related Motivation

achievements (DF2), and reward long-term milestones with badges that are visible in an awards overview [106, 108] (DF3). The PCA can visualize the learning progress via progress bars that fill up based on points earned [108] (DF4). In addition, the PCA should use levels per topic that also increase based on points earned (DF5). These levels lead users to perform better due to seeing their progress [68]. Hence, we derive DP1, according to which the PCA should act as a motivator that rewards students in a performance-related manner (Figure 2).

The following DP contains mechanisms of the PCA acting as a tutor at the beginning of the learning process and as a mentor later. It is crucial that the PCA performs a clear role since (AI-based) agents better perform their function when they are in a particular relationship with the user according to social agency theory [12, 66]. This is because people behave human-like toward these agents and apply similar expectations to them as they have towards humans, according to CASA theory [75, 100]. In the following, we first elaborate on the mechanisms of the PCA in a tutor role and then on the mechanisms of the PCA in a mentor role. First, users desired to be quizzed at the end of learning units to check their understanding of new learning content (US4). This continuous practice could increase learners' self-efficacy [6, 109]. Consequently, the PCA should test new content after each lesson so that users can review what they have learned and build confidence regarding their skills (MR4). In addition, learners wished to practice even when time is limited (US5). Therefore, the PCA should offer short quizzes so learners can study in small time slots (MR5). The ability to take quizzes in small time slots can increase learners' motivation, for instance, they have the chance to repeat the lesson on their way to the university [11, 120]. Students perceived it as important that the PCA acts as a tutor at the beginning of the learning process by teaching content and training lower-level learning goals such as remembering facts [4, 13]. This role should be communicated clearly (US6). Furthermore, learners need to be able to repeat the knowledge (US7). Therefore, designers should implement the spacing effect, according to which the recall of knowledge in increasingly longer intervals favors its long-term memorization [16, 87]. Overall, the PCA should repeat learning content using summaries and quizzes, and the PCA should allow for spaced repetition learning so that students can recall the knowledge confidently (MR6). The PCA should adapt its role later by acting as a mentor that builds a friendly relationship with learners [55]. In doing so, the PCA should address higher- level learning goals, such as the application and transfer of knowledge [4, 13]. Hints provided by the PCA can help learners find solutions for complex learning tasks [116]. Thus, learners could build multiple levels of learning competencies (MR7). Building competencies on multiple levels is crucial as it allows learners to achieve learning success [4, 13] and strengthens their sense of competence, which promotes self-efficacy and motivation [6, 55, 89, 109]. To implement the MRs, the PCA should first take on the tutor role to exercise learners at the end of a chapter (DF6). To do this, the PCA should, for example, access the calendar to identify opportune times to study and send reminders (DF7) [55, 80]. In addition, the PCA should repeat the content and offer summaries. Afterward, the PCA should start a quiz to recall what students have remembered (DF8) [2, 11, 80]. This quiz should be repeated at increasingly longer intervals. Furthermore, the PCA should act as a mentor by providing them with more complex learning tasks (e.g., open questions) [117]. In these tasks, the PCA could lead learners to apply knowledge and develop solutions for specific challenges. Within the mentoring role, participants explicitly wished the PCA to act as a classmate from a higher semester. In that way, the PCA can establish a co-equal relationship with their users [55, 103] and act as a student that has already passed the exam so that learners perceive its help as credible [56] (DF9). Hence, we derive DP2 regarding knowledge acquisition and application (Figure 3).

Interviewees expressed the desire to align their learning process with self-defined or suggested learning goals (US8). Specific and challenging goals can help improve learning performance [62, 64]. Furthermore, if learners can influence the learning goals themselves, this can lead to a higher acceptance of the learning goals according to the goal-setting theory [62, 64]. Own or influenceable learning goals can be perceived as more relevant [62, 64], contributing to users feeling autonomous and hence fosters their motivation [52, 89]. This enables users to learn self-regulated, i.e., to independently determine the learning process [14, 94]. Consequently, the PCA should allow learners to set their own learning goals so that they can incorporate their interests and perceive the learning goals to be relevant and valuable [94] (MR8). At the same time, the PCA should support the students if they have difficulties setting up their

DP2: Knowledge Acquisition and Application	
Aim and User	To design a gamified PCA that reviews and practices the learning content with students to foster their **self-efficacy** and to establish a **friendship-like relationship**,
Context	design the PCA in the roles of a **tutor** and a **mentor**.
Mechanisms	**In the role of a tutor, the PCA should:** • conduct quizzes at the end of each chapter or learning unit to practice the new learning content • offer learners a quick quiz via reminders so that they can efficiently check their knowledge on the go or during breaks • present learners with a summary of older learning content and have them repeat in a quiz using spaced repetition learning **In the role of a mentor from a higher semester, the PCA should:** • practice more complex learning tasks, e.g., using open-ended questions or specific use cases • award badges for special achievements
Rationale	The mechanisms enable learners to realize that they can recall what they have learned, make progress, and test the knowledge spontaneously. Practicing what they have learned may have a positive effect on learners' self-efficacy. From the perspective of the social agency theory, the role of the PCA is vital to adequately support students in achieving their learning goals. In addition, the mechanisms contribute to strengthening the learners' skills because by incorporating tasks for higher-level learning goals of Bloom's taxonomy. According to the spacing effect, spaced repetition learning helps to memorize knowledge long-term.

Figure 3: DP2 of Knowledge Acquisition and Application

own goals or formulating them according to the SMART concept as specific, measurable, attainable, realistic, and time-related [29] (MR9). The PCA's support of goal-setting is useful because some students lack self-regulation skills, making it difficult for them to set goals on their own [118], negatively affecting their learning success [121]. For instance, many students set unrealistic goals, which leads to disappointment for them and they hence perceive learning to be a burden [99]. Setting clear and realistic goals makes learners more likely to complete the course successfully and is perceived positively by students [43, 95]. The learners wished the PCA to ensure regular reflection on students' learning progress [17, 43, 117] (US9). Such self-reflection leads students to train themselves to plan ahead for their learning and to learn from their mistakes [124]. This can enable students to be satisfied with their learning progress and to be confident about achieving their learning goals [59] (MR10). Being satisfied when learning contributes to motivation [52]. In addition, students wished to divide goals according to their time horizon (US10). Accordingly, the PCA should highlight and reward the achievement of short-, medium-, and long-term learning goals [59] (MR11). These successes foster that learners perceive themselves to be competent [89]. The MRs can be implemented by having the PCA establish learning goals with the user at the beginning of the learning process based on the user's ideas and desires [43] (DF10). If needed, the PCA should make recommendations for learning goals based on the user's past performance to present individualized and realistically proposed goals (DF11). The PCA should furthermore support setting goals for each topic or section (DF12). For each (subordinate) goal, the PCA should moreover present the progress via progress bars and feedback [97] and reflect on it together with the student [117] (DF13). Finally, the PCA should reward the achievement of short-, medium-, and long-term learning goals [91]. Learners should receive the highest rewards when achieving long-term goals, so that the reward is performance-based and that they value the long-term goal as well as the rewards that come with it [77] (DF14). Hence, we derive DP3 of goal-setting and reflection (Figure 4).

Furthermore, narratives can be used to apply knowledge in real-life situations [35] (US11). The narrative's content should align with the user's learning goal to be perceived as relevant [3, 52]. The narrative should involve the learner constructively and interactively, as

DP3: Goal-Setting and Reflection	
Aim and User	To design a gamified PCA that helps learners set goals and reflect on their progress to perceive their learning goals as **valuable and relevant** and thus build **self-efficacy**,
Context	design the PCA as a facilitating **mentor**.
Mechanisms	Therefore, the PCA should: • allow students to set their own learning goals at the beginning of the learning process by giving them space to incorporate their own interests and ideas • provide suggestions for learning goals, if students should have difficulties defining their own learning goals • divide learning goals into short-, medium-, and long-term goals to help guide students through the learning process • regularly reflect on the learning progress together with the students regarding the defined goals
Rationale	The mechanisms contribute to the user feeling autonomous, having a higher interest in the learning goals, and being able to recognize their own progress. Furthermore, learners wish to be able to work toward something. According to goal-setting theory, they better accept learning goals that they have influenced by themselves. As a result, they strive for higher performance in achieving them. Furthermore, this may lead to learners having feelings of relevance, confidence, and satisfaction that positively affect their motivation, according to the ARCS model. Moreover, according to the self-determination theory, rewarding success promotes learners' perception of competence.

Figure 4: DP3 of Goal-Setting and Reflection

DP4: Learning Story Narration	
Aim and User	To design a gamified PCA that learners will **trust** and that helps them appreciate **the relevance of learning content,**
Context	design the PCA as an initiating but not actively participating **narrator**.
Mechanisms	Therefore, the PCA should: • introduce narratives that are related to life and that can be influenced by the user • not be actively involved in the narrative, but rather act as a passive narrator that confronts the user with problem situations to overcome • subdivide the narrative into achievable subgoals (e.g., quests) that are adapted to the user's skills so that they feel they progress successively
Rationale	Learners aim to apply their knowledge to realistic problems, continuously progress, and overcome challenges autonomously. It is crucial to support learners in solving practical problems to enable them to perceive the learning content as relevant. This imparts their motivation to learn, according to the ARCS model. Furthermore, according to the ICAP framework, constructive and interactive learning promotes the absorption of information. In addition, according to Bloom's taxonomy, knowledge application fulfills higher-level learning goals. According to the social agency theory, the PCA's role in the narrative should be kept constant to avoid irritation. Moreover, autonomous progress and success can increase self-efficacy. According to the goal-setting theory, subdividing the narrative is useful to pursue clear goals. According to the flow theory, the challenges should be adapted to the learners' skills to contribute to achieving an optimal learning state of learning.

Figure 5: DP4 of Learning Story Narration

according to the ICAP framework, this favors learning success [19]. The story should enable the user to demonstrate problem-solving skills [26, 35, 63]. In this way, learners can practice higher-level learning goals to enhance their skills [4, 13] (MR12). The role of the PCA in the narrative was also important to the participants (US12). They desired the PCA to initiate and accompany the narrative but not be part of it to maintain its credibility. Thus, according to social agency theory, the PCA can better fulfill its function as a narrator [66]. The PCA should support the students in their learning process by giving hints, so the PCA needs to have a higher level of knowledge than the user. Learners expressed that if the PCA had a participatory role, they would perceive this as a violation of the PCA's role. For example, if the PCA pretends to be unaware of tasks, users may find this untrustworthy. Furthermore, we assume that users' self-efficacy could increase by completing the narrative independently [6, 82]. Therefore, we suggest the PCA to initiate and accompany the narrative without being involved to create a clear role (MR13). Furthermore, participants desired the PCA to divide the narrative into multiple challenges [57] (US13). According to goal-setting theory, these challenges represent clear objectives, so that the user can continuously be aware of his/her progress [62, 64]. The PCA should adapt these challenges to the capabilities of the learner. This creates a state in which the user is neither under nor over-challenged, leading to a complete absorption in the narrative according to flow theory [24] (MR14). The MRs can be implemented by having the PCA introduce narratives that are life-relevant and whose progression depends on the users' responses [26, 77]. In doing so, the PCA should act as a narrator that presents users with a problem situation to overcome [50] (DF15). By challenging learners to solve problems on their own, and by encouraging them to achieve success in solving problems, learners are empowered in their self-efficacy, thereby increasing their motivation [6]. In addition, the PCA should subdivide the narrative into achievable subgoals (e.g., using quests) adapted to the user's abilities so that the student feels that he/she is making successive progress [59] (DF16). Hence, we derive DP4, according to which the PCA should act as a learning story narrator (Figure 5).

The following DP refers to mechanisms fostering collaboration and competition among peers because both tend to motivate students [31]. The students wished that the PCA supports them in finding learning partners (US14). This is consistent with further recent literature which states that many learners desire social interaction with their peers (esp. in digital education) [55, 76, 84]. The PCA should only suggest learning partners that are at the same level of knowledge to enable horizontal comparison following social comparison theory [33, 91]. This is crucial because competition, if not adequately designed, can lead to frustration among players [91]. Horizontal comparison allows learners to realistically assess their own skills and recognize that they can only win the competition by putting in effort [61, 91, 101]. This ensures that the collaboration among learners is based on an equal relationship (MR15). They have to solve specific tasks like quizzes and joint narratives [12, 96]. The PCA should take a moderator role in collaborative learning to accompany the exchange between the learners [54] (US15). According to the zone of proximal development, the PCA should support the learners to varying degrees [111, 116]. If the users are still at the beginning of their learning process, the PCA should clearly point out errors to them. If the learners have already reached a higher level, the PCA should only subtly point out errors. For instance, the PCA could ask learners to explain unclear content to each other and give some hints. In this way, the PCA could help learners apply the learning techniques of "elaborative interrogation" and "self-explanation," which educational researchers assume to be very effective [30]. These learning techniques are based on solving self-made questions and explaining circumstances to classmates [30]. In summary, the PCA as a moderator should ask learners to explain the learning content to each other in their own words, support them when needed, and highlight errors (MR16). This allows learners to help and correct each other. Overall, joint learning might strengthen learners' social relatedness [28, 89]. Learners also wished to get rewarded by the PCA when learning collaboratively (US16, US17). However, in social contexts, rewards must correspond to the expended effort of an actor; otherwise, this is perceived as unfair according to equity theory [1, 93].

DP5: Challenging Moderation of Learning with Peers	
Aim and User	To design a gamified PCA that promotes students' **perceptions of social relatedness, enjoyment, and satisfaction,**
Context	design the PCA as a **moderating challenger** regarding collaborative and competitive learning.
Mechanisms	Therefore, the PCA should: • connect learners with friends or new classmates that are at a similar level of knowledge, either by letting them search for peers or by automatically matching students • support the learners by giving hints when problems arise (so-called "scaffolding") • encourage students to apply learning techniques like „elaborative interrogation and "self-explanation" by asking them to explain the learning content to each other • set joint challenges like quizzes or narratives, which are worked on together. Upon completion of the challenges, the PCA should give rewards in the form of points, virtual goods (e.g., coins), or badges to everyone equally. • enable learners to compete against each other, either alone or in teams. Upon completion, all parties involved should be rewarded via points, virtual goods (e.g., coins), or badges, but the winning party should receive a higher reward.
Rationale	Users wish to learn both collaboratively and competitively. The PCA should encourage interaction with classmates as well as review and compare learners' levels of knowledge. According to social comparison theory, horizontal comparison with learners at the same knowledge level contributes to more realistic assessments of their abilities. According to the zone of proximal development, learners need less support („scaffolding") from the PCA as their knowledge increases. Following equity theory, rewards awarded by the PCA should be in accordance with the learners' performance to create a fair learning environment. According to the self-determination theory, joint learning contributes to feelings of social relatedness, positively influencing learners' motivation.

Figure 6: DP5 of Challenging Moderation of Learning with Peers

Thus, the PCA should equally reward learners actively participating in joint learning to recognize the performance of all. In summary, the PCA should present students with collaborative challenges and reward all players equally to recognize their effort and promote social relatedness (MR17). Furthermore, learners wished to compete against each other. In this context, the PCA should recognize all players for their participation but give a higher reward to the winning party for its better performance [1, 93] (US17). This helps to adequately acknowledge the learners' individual performance and to promote learners' enjoyment (MR18). To connect students, they could either search for peers by themselves or the PCA could match students with each other [55] (DF17). The PCA should use "scaffolding" to guide students when problems arise and encourage them to explain the content to each other [111, 116] (DF18). For collaboration, learners should receive common challenges such as quizzes or narratives to solve them together. Upon completion of the challenge, the PCA should reward students using points, virtual goods, or badges. In competitive learning, the PCA should allow users to compete against each other in a quiz, either alone or in teams [122]. All students should be rewarded upon completion, with the winning party receiving a higher reward (DF20). Hence, we derive DP5 regarding the challenging moderation of learning with peers (Figure 6).

5 INSTANTIATION AND EVALUATION OF DESIGN PRINCIPLES

To illustrate our design knowledge, we created a UX prototype using the tool "Figma" (Figure 7). We created a variant with the compliance of the DP for each of the five DPs, and a baseline artifact. The baseline artifact implements the basic features of gamified PCAs but does not fully satisfy the mechanisms of the DPs. The chatbot has a human-like name, "Ben," and accompanies students in learning English. We chose the subject of English learning to create a scenario that is understandable to many learners regardless of the specific content. This allowed us to focus on evaluating the design rather than the content. In line with the DPs, the PCA includes both tasks that address low-level learning goals, such as single-choice and multiple-choice quizzes, and tasks that address more complex learning goals, such as open-ended tasks and learning stories [4, 13]. The quiz tasks are, for example, grammar questions to test students' knowledge of tenses. Open tasks include the application of tenses, such as creating one's own sentences in English based on the previously learned tense. Learning stories, on the other hand, represent practical tasks. For example, the chatbots contains the learning story "The Roman Colosseum," in which the learner has to solve various quests, such as ordering a taxi to the Colosseum or asking for a discount on student tickets. In addition, the chatbots contains aspects that address self-regulated learning in the sense of DP1-DP4 and social learning in the sense of DP5 (both collaborative and competitive). Figure 7 shows excerpts of the conversation with Ben (for the baseline artifact and for the artifact with DP compliance). In the following, we will explain the differences between both versions.

In DP1, the PCA awards the rewards performance-related, i.e., the PCA considers that they relate to the time horizon of the goal (from short-term to long-term goals). In the baseline artifact, the rewards are not aligned with the learning goals and their time horizon. Instead, the PCA only congratulates the learners verbally. Regarding DP2, the PCA acts as a fellow student from a higher semester that supports like a real classmate, for example, with specific hints. In the baseline artifact, the PCA acts as a higher-level tutor and cannot give hints. With respect to DP3, learners can autonomously formulate goals and visualize their progress towards these goals. In the baseline artifact, the PCA instead specifies the goals themselves and learners are only informed of their progress via message but cannot view it visually. For DP4, the PCA introduces the learning story and divides it into different quests without being directly involved in it, while in the baseline artifact, the PCA has a participatory role, and the story is not divided into quests. In DP5, the PCA connects the learners with further students at the same level, moderates the collaborative and competitive learning,

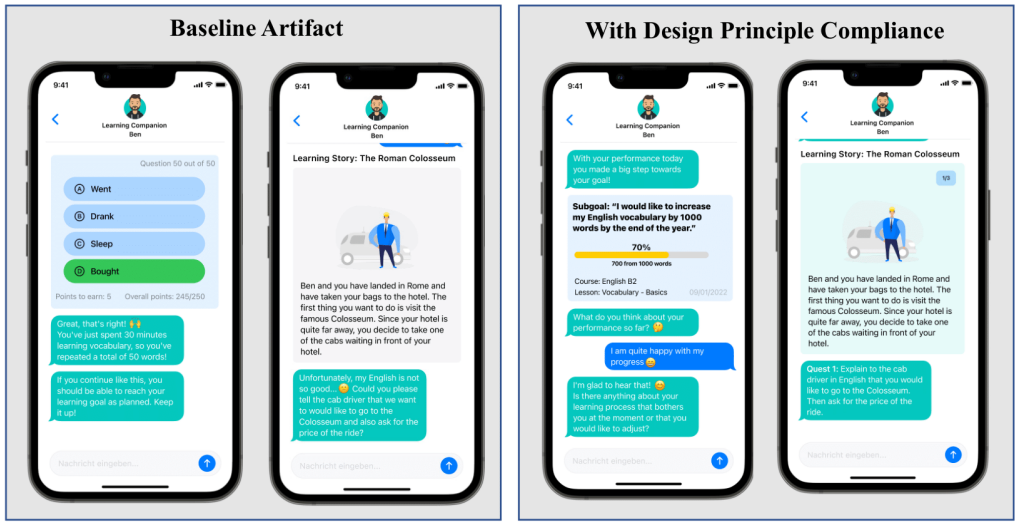

Figure 7: Excerpts of the Conversation with the PCA

Table 1: Differences between the Baseline Artifact and the Artifact with Design Principle Compliance

DP	Baseline Artifact	With Design Principle Compliance
DP1	• Verbal feedback to reward positive performance instead of points, coins, and badges. • Verbal indication of the learning progress (e.g., "Soon you will have completely mastered this lesson")	• Performance-related rewards (points for answering individual questions, coins as virtual goods for medium-term successes, badges for special successes such as the error-free passing of a quiz question in the first attempt). • Visualization of learning progress through levels and progress bars (per topic)
DP2	• Representation of Ben as a more senior professor who has been teaching the course for several years • Pure teaching of learning content	• Representation of Ben as a student from a higher semester • Tutor and mentor functions (in addition to the pure teaching of learning content, e.g.: summaries of the content, correction of wrong answers, application tasks including hints, spaced repetition learning)
DP3	• No autonomous and individualized formulation of learning goals (users have to achieve predefined learning goals)	• Users can set their own learning goals and receive ideas from Ben on how to formulate them if needed • Support for formulating learning goals with different time horizons (from an overarching vision to sub-goals for individual courses or lessons)
DP4	• Role of Ben as a facilitator, that is part of the story and asks the learner for help, but cannot give any hints • No communication of the overall progress and no subdivision of the story into subgoals	• Role of Ben as the narrator of the learning story, who introduces it (e.g., "Imagine...") and can give tips and hints when learners make a mistake and get stuck • Subdivision of the learning story into sub-challenges, which are presented as quests
DP5	• No matching of learners on the same level • The PCA does not intentionally encourage collaboration (e.g., learners can vote on individual quiz questions without exchanging ideas) • The PCA awards rewards only for the winning team and coins are individually distributed to single team members based on their individual performance • No hints during the collaborative processing of the tasks	• Ben matches learners at the same level with each other to have teams of the same strength competing against each other. • Ben supports collaboration among participants (e.g., by asking them to explain and discuss mistakes to each other) • Ben rewards all teams and their members for collaboration • Hints for students when they work on tasks collaboratively

Table 2: Study Results

TP	Construct	Baseline Artifact		With DP Compliance		t-Test		
		MV	SD	MV	SD	T	p	d
TP1	Competence [47]	4.39	1.35	5.14	1.36	6.17	< 0.01	0.78
TP2	Friendship (Help) [69, 103]	2.85	1.50	5.54	1.31	11.59	< 0.01	1.33
	Self-Efficacy [58]	3.65	1.47	5.06	1.48	7.43	< 0.01	0.85
TP3	Value/Usefulness [88]	4.85	1.48	5.81	1.36	6.43	< 0.01	0.74
	Relevance & Goal-Orientation [18, 52]	4.71	1.38	5.71	1.48	6.19	< 0.01	0.71
	Self-Efficacy [58]	4.50	1.41	5.39	1.48	6.01	< 0.01	0.69
TP4	Trusting Beliefs [81]	3.76	1.51	5.60	1.50	9.03	< 0.01	1.04
	Relevance & Goal-Orientation [18, 52]	4.38	1.62	5.46	1.54	5.51	< 0.01	0.63
TP5	Social Experience [46]	3.05	1.45	5.43	1.35	11.90	< 0.01	1.37
	Enjoyment & Satisfaction [18, 52]	3.46	1.42	5.24	1.42	9.61	< 0.01	1.10

MV = Mean Value; SD = Standard Deviation; p = Significance; T = t-Value; d = Effect Size; TP = Testable Proposition

and the learners can exchange in the team. The competition is designed in a way that the chatbot lets two teams with the similar level compete against each other and presents them with tasks such as open-ended questions and learning stories in which the learners can exchange ideas in the team about the correct answer. DP5 is designed to encourage team members to work together. In the baseline artifact, there is no moderation but a passive accompaniment, and no exchange within the team is possible. Table 1 summarizes the differences between both versions.

We evaluated our DPs in an online survey lasting approx. 30-35 minutes. For each of the DPs, the participants could watch two video scenarios (with DP compliance and baseline artifact) and were asked to rate them afterward. We randomized the order of the items as well as the PCA variants. We set up testable propositions (TPs) and identified constructs that correspond to the mechanisms and objectives of the DPs, as common in design science research for evaluating design DPs [39, 70]. In the following, we will elaborate on each of the TPs, indicating the source of the construct at the end of each sentence. According to DP1, we assume that a gamified PCA that rewards students through various game elements and visualizes their progress increases learners' perceptions of competence [47] (TP1). According to DP2, a gamified PCA that supports students in knowledge acquisition and transfer could foster students' perceptions of friendship with the PCA [69, 103] as well as their self-efficacy [58] (TP2). According to DP3, a gamified PCA that supports students in setting goals and reflecting on them, could contribute to the perceptions of usefulness [88], relevance/goal-orientation [18, 52], as well as self-efficacy [58] (TP3). According to DP4, a gamified PCA that initiates narratives and accompanies them during the narrative could increase users' trusting beliefs [81], as well as the perceptions of relevance and goal-orientation regarding the challenges to be solved [18] (TP4). According to DP5, a gamified PCA that promotes collaborative and competitive learning could increase learners' social experience [46] and their enjoyment and satisfaction in learning [18, 52] (TP5). We used a 7-point Likert scale for all items (1 = strongly disagree to 7 = strongly agree). 76 learners participated in our study (39 female, 35 male, and two diverse). The average age was 26 years. Cronbach's alpha was > 0.9 for all constructs, and the corrected inter-item scale correlation was always > 0.3 [41, 79]. Confirmatory factor analysis confirmed the suitability of the data set, as all factor loadings were > 0.5 [20], explained variances were > 0.5 [5], and KMO values were > 0.5 [49]. We calculated the mean values and standard deviations for each TP. Moreover, we performed a paired Student's t-test to check whether the mean values of both variants differ significantly for the individual constructs ($\alpha = 0.05$). Participants rated the version in compliance with the DPs very positively. All values are above the scale mean and even > 5. The baseline artifact was rated worse for each construct, with mean values ranging from 2.85 to 4.85. The t-test revealed a significant difference for all constructs, confirming our TPs ($p < 0.01$). For some TPs, this is a strong effect (Cohen's $d > 0.8$), and for the remaining ones, this is a medium effect ($0.5 <$ Cohen's $d < 0.8$) [22]. Table 2 shows the study results.

6 DISCUSSION

6.1 Implications of the Findings

First, we combine the current emerging approach of PCAs as an interactive way of learning [45, 54] with the established approach of gamification as one way for motivational boost [25, 97]. Our approach aims to exploit the benefits of both forms of technology-enhanced learning. The combination of PCAs with gamification is quite new, as literature reviews have shown that few researchers have yet contributed knowledge in this area [12, 53]. The gamified PCA approach differs from current chatbots such as ChatGPT, which are mostly pretended to answer users' questions and thus impart knowledge [51]. Instead, gamified PCAs go further than just imparting knowledge by helping learners to achieve learning goals in an interactive way, from knowledge acquisition to higher learning goals such as knowledge application [4, 13], as also called for by other PCA researchers [55, 95]. This was highlighted positive by the study participants, for instance: "The interactive learning stories are a great idea. The feature to self-formulate answers seems to increase the learning success, since you have to formulate the correct answer on your own and not just pick it out of given possibilities. The open communication with the chatbot Ben does not give the feeling that you are learning with an app, but rather as if you are actually working together with a human

teacher." Overall, we aim to increase learners' motivation not only in the short-term, but instead by guiding them to be motivated in the long-term, for instance, by encouraging them to set own goals and to keep track of their progress. This finding is supported by recent studies which highlight that learners desire long-term motivational support through PCAs [11, 55, 84, 84]. Study participants, i.e., addressed that the visualization of their learning progress contributes to their long-term motivational support. For example, one participant addressed: "The badges are very handy and help you capture the current learning status, i.e., the "ready for the exam" badge."

Second, our design approach incorporates approaches to self-regulated learning as well as collaborative and competitive learning. For example, with the support of the PCA, it is possible to set own learning goals and work on learning stories independently, as well as complete learning tasks in teams and compete against other teams. This variety of learning methods was emphasized by the survey participants in their answers to the open-ended questions. For instance, one student said, "I liked the progress indicators and mechanisms for goal-setting, as well as the learning stories which included tips from Ben. That motivates me to learn and leads me to gain more knowledge from the learning sessions." At the same time, participants addressed, "I really liked the opportunities to learn together with learning partners and interact with them. They are way better designed as compared to the alternative prototype."

Third, we show how to design PCAs to be valuable for their users to counteract the practical problem that many PCAs implementations are unsatisfactory and fail [78]. By combining PCAs with gamification, we create a motivational incentive to encourage long-term PCA use which helps learners recognize the value of the PCA as outlined by further researchers [12, 55, 95]. So far, we have been able to show the effectiveness of our design approach for the context of English language learning. However, study participants criticized whether this approach is transferable to more complex content, with one respondent saying, "Ben appears to only be viable for simple structured subjects. For more complex subjects like mathematics, physics or similar, its use is probably not that helpful." Especially in the context of English language learning, learners may have been "positively biased" because they are used to learn through mobile and gamified language learning applications such as "Duolingo." Existing literature on gamified PCAs has also shown that language learning is a popular use case for gamified PCAs [53], however, researchers have already revealed positive results on gamified PCAs in other contexts such as computer science [2], information literacy [35], or environmental engineering [40]. Previous literature also mentioned this limitation for gamified PCAs [53]. For example, learning soft skills could be more difficult when applied in a chatbot. We are therefore working on using gamified PCAs in full-fledged games to benefit from the advantages of an existing game environment. The success of gamified PCAs could also depend on many variables, for example, the extent to which learners already use digital tools within their learning strategy and are open to such tools, or whether learners already have a minimum level of motivation or enthusiasm for their subject. Furthermore, we are currently working on transferring our approach to other application contexts such as business information systems education to validate if it is suitable in other contexts as well. To implement a satisfactory solution for more complex issues, we see potential in leveraging the emerging trend towards large language models, such as the one used by ChatGPT, which allow developers to better evaluate students' responses to open-ended tasks provided by the PCA [51]. Hence, we plan to include an interface of our PCA to large language models in subsequent development iterations.

Fourth, our design knowledge provides an overview that can guide designers and developers to implement gamified PCAs. Our DPs and the associated MRs and DFs are prescriptive recommendations that can enable them to transfer these scientific findings to practice.

6.2 Limitations

We admit the limitations of our paper. So far, the evaluation is only based on a conceptual prototype and the participants did not interact with the PCA. We chose this approach to first test the effectiveness of our design proposal before technically implementing the prototype. In our second design cycle, we plan to validate the results with a mature prototype and real user interactions. Second, our sample size (n = 76) is quite small. We chose this evaluation procedure to show a first proof-of-concept and because researchers emphasize that a t-test as in our evaluation is already considered meaningful with a sample size of $n \geq 30$ [41]. In contrast, we plan to conduct an evaluation with the mature prototype and a higher sample size to show a proof-of-value as well.

7 CONCLUSION AND OUTLOOK

Gamification of PCAs helps to make interactions with them more engaging, enabling to better guide learners. Since there is a lack of design knowledge regarding gamified PCAs, we have derived 18 MRs, five DPs, and 20 DFs. We exemplified this design knowledge in a prototype, and our first experimental results show the efficiency of our DPs. Current trends such as ChatGPT show that learning with AI-based PCAs is becoming more present in digital education. In addition to the technical design of PCAs, researchers consider it essential to also contribute knowledge about how to increase learners' motivation [11, 55]. The artifacts presented in this paper make a first contribution to research and practice by showing how such a realization could look like. We are currently working on implementing the PCA. For this purpose, we use the framework "Rasa" and have integrated the PCA into the tool "Slack" to allow for collaboration as suggested by DP5. In addition, we created an interface from Rasa to a language checking tool to check the correctness of the sentences entered by the learners in open tasks and to give hints and suggestions for improvement in case of an incorrect answer. We plan to conduct another experiment in the next design cycle, in which learners assess the interaction with the PCA regarding the identified constructs. In this way, we hope to show the effectiveness of our DPs in a real-world learning scenario as well. In addition, we plan to add more subjects to our PCA to validate our design knowledge's transferability to other contexts.

ACKNOWLEDGMENTS

This contribution results from the project StuBu (grant # 21INVI06), which the German Federal Ministry of Education and Research (BMBF) funded.

REFERENCES

[1] J Stacy Adams. 1965. Inequity in social exchange. In *Advances in experimental social psychology*. Elsevier, 267–299.

[2] C.C. Aguirre, C.D. Kloos, C. Alario-Hoyos, and P.J. Munoz-Merino. 2018. Supporting a MOOC through a conversational agent. Design of a first prototype. In *SIIE 2018 Proceedings*.

[3] Shoug Alfadhli and Asmaa Alsumait. 2015. Game-Based Learning Guidelines: Designing for Learning and Fun. In *2015 International Conference on Computational Science and Computational Intelligence (CSCI)*, IEEE, Las Vegas, NV, USA, 595–600. DOI:https://doi.org/10.1109/CSCI.2015.37

[4] Lorin W Anderson and David R Krathwohl. 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman, New York.

[5] Klaus Backhaus, Bernd Erichson, Wulff Plinke, and Rolf Weiber. 1994. *Multivariate Analysemethoden Eine anwendungsorientierte Einführung*. Springer Verlag. Retrieved April 7, 2021 from https://doi.org/10.1007/978-3-662-12552-6

[6] Albert Bandura. 1977. Self-efficacy: toward a unifying theory of behavioral change. *Psychological review* 84, 2 (1977), 191–215.

[7] Albert Bandura and Richard H Walters. 1977. *Social learning theory*. Englewood cliffs Prentice Hall.

[8] Gabriel Barata, Sandra Gama, Joaquim Jorge, and Daniel Gonçalves. 2017. Studying student differentiation in gamified education: A long-term study. *Computers in Human Behavior* 71 (June 2017), 550–585. DOI:https://doi.org/10.1016/j.chb.2016.08.049

[9] Richard Baskerville, Abayomi Baiyere, Shirley Gregor, Alan Hevner, and Matti Rossi. 2018. Design Science Research Contributions: Finding a Balance between Artifact and Theory. *Journal of the Association for Information Systems* 19, 5 (May 2018).

[10] Andreas Behr, Marco Giese, Herve D. Teguim Kamdjou, and Katja Theune. 2021. Motives for dropping out from higher education—An analysis of bachelor's degree students in Germany. *European Journal of Education* 56, 2 (2021), 325–343.

[11] Dennis Benner, Sofia Schöbel, and Christoph Süess. 2022. Towards Gamified Conversational Agents for Self-Regulated Learning in Digital Education. In *ICIS 2022 Proceedings*, Copenhagen, Denmark.

[12] Dennis Benner, Sofia Schöbel, Christoph Süess, Vera Baechle, and Andreas Janson. 2022. Level-Up your Learning – Introducing a Framework for Gamified Educational Conversational Agents. In *Wirtschaftsinformatik 2022 Proceedings*.

[13] Benjamin Samuel Bloom. 1956. *Taxonomy of educational objectives: The classification of educational goals, 1st ed.* Longman Group, Harlow, Essex, England.

[14] Monique Boekaerts. 1999. Self-regulated learning: where we are today. *International Journal of Educational Research* 31, 6 (January 1999), 445–457.

[15] Jan vom Brocke, Robert Winter, Alan Hevner, and Alexander Maedche. 2020. Special Issue Editorial –Accumulation and Evolution of Design Knowledge in Design Science Research: A Journey Through Time and Space. *JAIS* 21, 3 (May 2020), 520–544.

[16] Nicholas J. Cepeda, Edward Vul, Doug Rohrer, John T. Wixted, and Harold Pashler. 2008. Spacing effects in learning: a temporal ridgeline of optimal retention. *Psychol Sci* 19, 11 (November 2008), 1095–1102. DOI:https://doi.org/10.1111/j.1467-9280.2008.02209.x

[17] Yu Chen, Tianjie Zhu, Simran Bhalla, Nitin Aggarwal, and Larry Gee. 2022. A Conversational Goal Setting Buddy for Student Learning. In *AMCIS 2022 Proceedings*.

[18] Zhi-Hong Chen and Tak-Wai Chan. 2008. Learning by Substitutive Competition: Nurturing My-Pet for Game Competition Based on Open Learner Model. In *Second IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning*, Banff, AB, Canada.

[19] Michelene T. H. Chi and Ruth Wylie. 2014. The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes. *Educational Psychologist* 49, 4 (October 2014), 219–243.

[20] Wynne W. Chin. 1998. The partial least squares approach for structural equation modeling. In *Modern methods for business research*. Lawrence Erlbaum Associates Publishers, Mahwah, NJ, US, 295–336.

[21] Richard E. Clark and Sunhee Choi. 2005. Five Design Principles for Experiments on the Effects of Animated Pedagogical Agents. *Journal of Educational Computing Research* 32, 3 (April 2005), 209–225. DOI:https://doi.org/10.2190/7LRM-3BR2-44GW-9QQY

[22] Jacob Cohen. 1988. *Statistical power analysis for the behavioral sciences* (2nd ed ed.). L. Erlbaum Associates, Hillsdale, N.J.

[23] Thomas M. Connolly, Elizabeth A. Boyle, Ewan MacArthur, Thomas Hainey, and James M. Boyle. 2012. A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education* 59, 2 (September 2012), 661–686. DOI:https://doi.org/10.1016/j.compedu.2012.03.004

[24] Mihaly Csikszentmihalyi, Sami Abuhamdeh, and Jeanne Nakamura. 2014. Flow. In *Flow and the Foundations of Positive Psychology*. Springer Netherlands, Dordrecht, 227–238. DOI:https://doi.org/10.1007/978-94-017-9088-8_15

[25] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. 2011. From game design elements to gamefulness: defining "gamification." In *Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments*.

[26] Michele Dickey. 2005. Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. *Educational Technology Research and Development* 53 (June 2005), 67–83. DOI:https://doi.org/10.1007/BF02504866

[27] Stephan Diederich, Alfred Brendel, Stefan Morana, and Lutz Kolbe. 2022. On the Design of and Interaction with Conversational Agents: An Organizing and Assessing Review of Human-Computer Interaction Research. *Journal of the Association for Information Systems* (January 2022).

[28] Pierre Dillenbourg, Sanna Järvelä, and Frank Fischer. 2009. *The evolution of research on computer-supported collaborative learning: From design to orchestration*. Springer.

[29] George T. Doran. 1981. There'sa SMART way to write management's goals and objectives. *Management review* 70, 11 (1981), 35–36.

[30] John Dunlosky, Katherine A. Rawson, Elizabeth J. Marsh, Mitchell J. Nathan, and Daniel T. Willingham. 2013. Improving Students' Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychol Sci Public Interest* 14, 1 (January 2013), 4–58.

[31] Linda Eckardt and Rebecca Finster. 2019. Kollaboration oder Wettbewerb: ein Vergleich der Motivation beim Game-based Learning. *HMD* 56, 1 (February 2019), 83–93. DOI:https://doi.org/10.1365/s40702-018-00481-7

[32] D. Economou, I. Doumanis, V. Bouki, F. Pedersen, P. Kathrani, M. Mentzelopoulos, and N. Georgalas. 2015. A dynamic role-playing platform for simulations in legal and political education. 232–236. DOI:https://doi.org/10.1109/IMCTL.2014.7011138

[33] Leon Festinger. 1954. A theory of social comparison processes. *Human relations* 7, 2 (1954), 117–140.

[34] Asbjørn Følstad, Cecilie Bertinussen Nordheim, and Cato Alexander Bjørkli. 2018. What makes users trust a chatbot for customer service? An exploratory interview study. In *International conference on internet science*, 194–208.

[35] C.M. Forsyth, A. Graesser, and K. Millis. 2020. Predicting Learning in a Multicomponent Serious Game. *Technology, Knowledge and Learning* 25, 2 (2020), 251–277.

[36] Pia Gebbing, Bijan Khosrawi-Rad, Timo Strohmann, Charlotte Windolf, and Christoph Lattemann. 2023. A Virtual Companion for Lifelong Learning - Design Principles for Motivation, Social Learning, and Exam Preparation. In *Proceedings of the 36th Bled eConference*, Bled, Slovenia.

[37] Shirley Gregor, Leona Chandra Kruse, and Stefan Seidel. 2020. The Anatomy of a Design Principle. *Journal of the Association for Information Systems* 21, (2020), 1622–1652.

[38] Shirley Gregor and Alan R. Hevner. 2013. Positioning and Presenting Design Science Research for Maximum Impact. *MISQ* 37, 2 (February 2013), 337–355.

[39] Shirley Gregor and David Jones. 2007. The Anatomy of a Design Theory. *Journal of the Association for Information Systems* 8, 5 (May 2007), 312–335.

[40] F. Grivokostopoulou, K. Kovas, and I. Perikos. 2020. The effectiveness of embodied pedagogical agents and their impact on students learning in virtual worlds. *Applied Sciences* 10, 5 (2020). DOI:https://doi.org/10.3390/app10051739

[41] Joseph F. Hair, William C. Black, Barry J. Babin, and Rolph E. Anderson. 2014. *Multivariate data analysis* (7th ed.). Pearson.

[42] Juho Hamari, Jonna Koivisto, and Harri Sarsa. 2014. Does Gamification Work? — A Literature Review of Empirical Studies on Gamification. In *Proceedings of the Annual Hawaii International Conference on System Sciences*. DOI:https://doi.org/10.1109/HICSS.2014.377

[43] Khe Foon Hew, Weijiao Huang, Jiahui Du, and Chengyuan Jia. 2023. Using chatbots to support student goal setting and social presence in fully online activities: learner engagement and perceptions. *J Comput High Educ* 35, 1 (2023), 40–68. DOI:https://doi.org/10.1007/s12528-022-09338-x

[44] Sebastian Hobert. 2019. Say Hello to 'Coding Tutor'! Design and Evaluation of a Chatbot-based Learning System Supporting Students to Learn to Program. In *ICIS 2019 Proceedings*.

[45] Sebastian Hobert and Raphael Meyer von Wolff. 2019. Say Hello to Your New Automated Tutor – A Structured Literature Review on Pedagogical Conversational Agents. In *Wirtschaftsinformatik 2019 Proceedings*.

[46] Johan Högberg, Juho Hamari, and Erik Wästlund. 2019. Gameful Experience Questionnaire (GAMEFULQUEST): an instrument for measuring the perceived gamefulness of system use. *User Modeling and User-Adapted Interaction* 29, 3 (2019), 619–660.

[47] W. A. IJsselsteijn, Y. A. W. de Kort, and K. Poels. 2013. The Game Experience Questionnaire. (2013). Retrieved December 28, 2020 from https://research.tue.nl/en/publications/the-game-experience-questionnaire

[48] Antje Janssen, Lukas Grützner, and Michael H. Breitner. 2021. Why do Chatbots fail? A Critical Success Factors Analysis. In *ICIS 2021 Proceedings*.

[49] Henry F. Kaiser and John Rice. 1974. Little Jiffy, Mark Iv. *Educational and Psychological Measurement* 34, 1 (April 1974), 111–117. DOI:https://doi.org/10.1177/001316447403400115

[50] Karl M. Kapp. 2012. The gamification of learning and instruction: game-based methods and strategies for training and education. John Wiley & Sons, San

Francisco, CA.
[51] Enkelejda Kasneci, Kathrin Seßler, Stefan Küchemann, Maria Bannert, Daryna Dementieva, Frank Fischer, Urs Gasser, Georg Groh, Stephan Günnemann, and Eyke Hüllermeier. 2023. ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences* 103 (2023).
[52] John M. Keller. 1987. Development and use of the ARCS model of instructional design. *Journal of Instructional Development* 10, 3 (September 1987), 2.
[53] Bijan Khosrawi-Rad, Linda Grogorick, and Susanne Robra-Bissantz. 2023. Game-inspired Pedagogical Conversational Agents: A Systematic Literature Review. *AIS Transactions on Human-Computer Interaction* 15, 2 (June 2023), 146–192. DOI:https://doi.org/10.17705/1thci.00187
[54] Bijan Khosrawi-Rad, Heidi Rinn, Ricarda Schlimbach, Pia Gebbing, Xingyue Yang, Christoph Lattemann, Daniel Markgraf, and Susanne Robra-Bissantz. 2022. Conversational Agents in Education – A Systematic Literature Review. In *ECIS 2022 Proceedings*, Timișoara, Romania.
[55] Bijan Khosrawi-Rad, Ricarda Schlimbach, Timo Strohmann, and Susanne Robra-Bissantz. 2022. Design Knowledge for Virtual Learning Companions. In *Proceedings of the 2022 AIS SIGED International Conference on Information Systems Education and Research*, Copenhagen, Denmark.
[56] Yanghee Kim and Amy L Baylor. 2016. Research-Based Design of Pedagogical Agent Roles: a Review, Progress, and Recommendations. *International Journal of Artificial Intelligence in Education* 26 (2016), 160–169.
[57] Kathrin Knautz. 2015. Gamification in der Hochschuldidaktik – Konzeption, Implementierung und Evaluation einer spielbasierten Lernumgebung. Retrieved January 24, 2021 from https://docserv.uni-duesseldorf.de/servlets/DocumentServlet?id$=$36429
[58] J. Knispel, L. Wittneben, V. Slavchova, and V. Arling. 2021. Skala zur Messung der beruflichen Selbstwirksamkeitserwartung (BSW-5-Rev). *Zusammenstellung sozialwissenschaftlicher Items und Skalen (ZIS)* (2021).
[59] Jeanine Krath, Linda Schürmann, and Harald F. O. von Korflesch. 2021. Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior* 125, (December 2021), 106963.
[60] Bill Kuechler and Vijay Vaishnavi. 2008. On theory development in design science research: anatomy of a research project. *European Journal of Information Systems* 17, 5 (2008), 489–504.
[61] Richard N. Landers and Amy K. Landers. 2014. An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance. *Simulation & Gaming* 45, 6 (December 2014), 769–785. DOI:https://doi.org/10.1177/1046878114563662
[62] Gary P Latham, Deshani B Ganegoda, and Edwin A Locke. 2011. Goal-setting: A state theory, but related to traits. (2011).
[63] D. Lindholm, E.P. Brooks, and T. Nauerby. 2013. I see, please tell me more - Exploring virtual agents as interactive storytellers. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* 8018 LNCS, PART 3 (2013), 89–98. DOI:https://doi.org/10.1007/978-3-642-39226-9_11
[64] Edwin A Locke and Gary P Latham. 1990. *A theory of goal setting & task performance*. Prentice-Hall, Inc, Englewood Cliffs, NJ.
[65] Ana Manzano-León, Pablo Camacho-Lazarraga, Miguel A Guerrero, Laura Guerrero-Puerta, José M Aguilar-Parra, Rubén Trigueros, and Antonio Alias. 2021. Between level up and game over: A systematic literature review of gamification in education. *Sustainability* 13, 4 (2021), 2247.
[66] Richard E. Mayer, Kristina Sobko, and Patricia D. Mautone. 2003. Social Cues in Multimedia Learning: Role of Speaker's Voice. *Journal of Educational Psychology* 95, 2 (2003), 419–25.
[67] Philipp Mayring. 2015. *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (12th ed.). Beltz Verlag.
[68] Elisa D. Mekler, Florian Brühlmann, Klaus Opwis, and Alexandre N. Tuch. 2013. Do points, levels and leaderboards harm intrinsic motivation?: an empirical analysis of common gamification elements. In *Proceedings of the First International Conference on Gameful Design, Research, and Application*.
[69] M. J. Mendelson and F. Aboud. 2012. McGill Friendship Questionnaire-Respondent's affection (MFQ-RA). *Measurement Instrument Database for the Social Science* (2012).
[70] Hendrik Meth, Benjamin Mueller, and Alexander Maedche. 2015. Designing a Requirement Mining System. *Journal of the Association for Information Systems* 16, 9 (September 2015). DOI:https://doi.org/10.17705/1jais.00408
[71] Frederik Möller, Tobias Moritz Guggenberger, and Boris Otto. 2020. Towards a method for design principle development in information systems. In *Proceedings of the International Conference on Design Science Research in Information Systems and Technology*, Kristiansand, Norway.
[72] Frederik Möller, Thorsten Schoormann, Gero Strobel, and Magnus Hansen. 2022. Unveiling the Cloak: Kernel Theory Use in Design Science Research. In *ICIS 2022 Proceedings*.
[73] Dominique Morisano, Jacob B. Hirsh, Jordan B. Peterson, Robert O. Pihl, and Bruce M. Shore. 2010. Setting, elaborating, and reflecting on personal goals improves academic performance. *Journal of Applied Psychology* 95, 2 (2010), 255–264. DOI:https://doi.org/10.1037/a0018478
[74] Christian Moser. 2012. *User experience design*. Springer.
[75] Clifford Nass, Jonathan Steuer, and Ellen R. Tauber. 1994. Computers are social actors. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, ACM, 72–78.
[76] Munir Naveed, Muath Alrammal, Mukti Sharma, and Kausar Fatima. 2017. AIPRO: An AI Framework as a Student Learning Support Tool. *adv sci lett* 23, 8 (August 2017), 7666–7669. DOI:https://doi.org/10.1166/asl.2017.9548
[77] Scott Nicholson. 2015. A RECIPE for Meaningful Gamification. In *Gamification in Education and Business*, Torsten Reiners and Lincoln C. Wood (eds.). Springer International Publishing, Cham, 1–20. DOI:https://doi.org/10.1007/978-3-319-10208-5_1
[78] Marcia Nißen, Driton Selimi, Antje Janssen, Davinia Cardona, Michael Breitner, Tobias Kowatsch, and Florian Wangenheim. 2021. See you soon again, chatbot? A design taxonomy to characterize user-chatbot relationships with different time horizons. *Computers in Human Behavior* 127 (October 2021), 1–15.
[79] J Nunnally and I Bernstein. 1994. *Psychometric Theory* (3rd ed.). McGraw-Hill.
[80] X.L. Pham, T. Pham, Q.M. Nguyen, T.H. Nguyen, and T.T.H. Cao. 2018. Chatbot as an intelligent personal assistant for mobile language learning. In *ACM International Conference Proceeding Series*, 16–21.
[81] Lingyun Qiu and Izak Benbasat. 2009. Evaluating anthropomorphic product recommendation agents: A social relationship perspective to designing information systems. *Journal of Management Information Systems* 25, 4 (2009), 145–182.
[82] Ganit Richter, Daphne R. Raban, and Sheizaf Rafaeli. 2015. Studying Gamification: The Effect of Rewards and Incentives on Motivation. In *Gamification in Education and Business*, Torsten Reiners and Lincoln C. Wood (eds.). Springer International Publishing, Cham, 21–46. DOI:https://doi.org/10.1007/978-3-319-10208-5_2
[83] Lara Riefle and Carina Benz. 2021. User-Specific Determinants of Conversational Agent Usage: A Review and Potential for Future Research. In *Wirtschaftsinformatik 2021 Proceedings*. DOI:https://doi.org/10.1007/978-3-030-86797-3_8
[84] Heidi Rinn, Bijan Khosrawi-Rad, Ricarda Schlimbach, Martina Masurek, Susanne Robra-Bissantz, and Daniel Markgraf. 2022. Needs of Students in Further Education-A Mixed Methods Study. In *GeNeMe 2022 Proceedings*, Dresden, Germany.
[85] Errol Scott Rivera and Claire Louise Palmer Garden. 2021. Gamification for student engagement: a framework. *Journal of Further and Higher Education* 45, 7 (August 2021), 999–1012. DOI:https://doi.org/10.1080/0309877X.2021.1875201
[86] Karen Robson, Kirk Plangger, Jan H. Kietzmann, Ian McCarthy, and Leyland Pitt. 2015. Is it all a game? Understanding the principles of gamification. *Business Horizons* 58, 4 (July 2015), 411–420. DOI:https://doi.org/10.1016/j.bushor.2015.03.006
[87] Sherry Ruan, Liwei Jiang, Justin Xu, Bryce Joe-Kun Tham, Zhengneng Qiu, Yeshuang Zhu, Elizabeth L. Murnane, Emma Brunskill, and James A. Landay. 2019. QuizBot: A Dialogue-based Adaptive Learning System for Factual Knowledge. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. New York, NY, USA, 1–13.
[88] Richard M. Ryan. 1982. Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *Journal of Personality and Social Psychology* 43, 3 (1982), 450–461.
[89] Richard M Ryan and Edward L Deci. 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary educational psychology* 25, 1 (2000), 54–67.
[90] Michael Sailer, Jan Hense, Heinz Mandl, and Markus Klevers. 2013. Psychological perspectives on motivation through gamification. *Ixd&a* 19, 1 (2013), 28–37.
[91] Michael Sailer, Jan Ulrich Hense, Sarah Katharina Mayr, and Heinz Mandl. 2017. How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior* 69, (April 2017), 371–380.
[92] Diana R Sanchez, Markus Langer, and Rupinder Kaur. 2020. Gamification in the classroom: Examining the impact of gamified quizzes on student learning. *Computers & Education* 144 (2020), 103666.
[93] Stefanie Saremba. 2017. Motivation in der Verwaltung. Sozialwissenschaftliche Grundlagen des beruflichen Handelns: Handeln in Organisationen und öffentlichen Verwaltungen (2017), 189–232.
[94] Sven Scheu and Ivo Benke. 2022. Digital Assistants for Self-Regulated Learning: Towards a State-Of-The-Art Overview. In *ECIS 2022 Proceedings*.
[95] Ricarda Schlimbach, Charlotte Windolf, and Susanne Robra-Bissantz. 2023. A Service Perspective on Designing Learning Companions as Bonding and Mindful Time Managers in Further Education. *ECIS 2023 Proceedings* (2023).
[96] T. Schlippe and J. Sawatzki. 2022. AI-Based Multilingual Interactive Exam Preparation. *Lecture Notes in Networks and Systems* 349 LNNS, (2022), 396–408. DOI:https://doi.org/10.1007/978-3-030-90677-1_38
[97] Sofia Marlena Schöbel, Andreas Janson, and Matthias Söllner. 2020. Capturing the complexity of gamification elements: a holistic approach for analysing existing and deriving novel gamification designs. *European Journal of Information Systems* 29, 6 (2020), 641–668.

[98] Anna-Maria Seeger and Armin Heinzl. 2021. Chatbots often Fail! Can Anthropomorphic Design Mitigate Trust Loss in Conversational Agents for Customer Service? In *Proceedings of the European Conference on Information Systems*.

[99] Kuei-Ping Shih, Hung-Chang Chen, Chih-Yung Chang, and Tai-Chien Kao. 2010. The Development and Implementation of Scaffolding-Based Self-Regulated Learning System for e/m-Learning. *Journal of Educational Technology & Society* 13, 1 (2010), 80–93.

[100] Dominik Siemon. 2022. Elaborating Team Roles for Artificial Intelligence-based Teammates in Human-AI Collaboration. *Group Decis Negot* 31, 5 (October 2022), 871–912. DOI:https://doi.org/10.1007/s10726-022-09792-z

[101] Robert E. Slavin. 1980. Cooperative Learning. *Review of Educational Research* 50, 2 (June 1980), 315–342. DOI:https://doi.org/10.3102/00346543050002315

[102] Pavel Smutny and Petra Schreiberova. 2020. Chatbots for learning: A review of educational chatbots for the Facebook Messenger. *Computers & Education* 151 (2020), 103862.

[103] Timo Strohmann, Dominik Siemon, Bijan Khosrawi-Rad, and Susanne Robra-Bissantz. 2022. Toward a design theory for virtual companionship. *Human–Computer Interaction* 38, 3–4 (July 2022), 1–41.

[104] Timo Strohmann, Dominik Siemon, and Susanne Robra-Bissantz. 2019. Designing virtual in-vehicle assistants: Design guidelines for creating a convincing user experience. *AIS Transactions on Human-Computer Interaction* 11, 2 (2019), 54–78.

[105] Jörg Strübing. 2018. *Qualitative Sozialforschung: Eine komprimierte Einführung*. Walter de Gruyter GmbH & Co KG.

[106] Chuen-Tsai Sun, Holin Lin, and Chheng Hong Ho. 2006. Sharing tips with strangers: Exploiting gift culture in computer gaming. *CyberPsychology & Behavior* 9, 5 (2006), 560–570.

[107] Armando M. Toda, Pedro H. D. Valle, and Seiji Isotani. 2018. The Dark Side of Gamification: An Overview of Negative Effects of Gamification in Education. In *Higher Education for All. From Challenges to Novel Technology-Enhanced Solutions*, Springer International Publishing, Cham, 143–156.

[108] A.Y. Utomo and H.B. Santoso. 2015. Development of gamification-enriched pedagogical agent for e-learning system based on community of inquiry. 1–9. DOI:https://doi.org/10.1145/2742032.2742033

[109] Mart Van Dinther, Filip Dochy, and Mien Segers. 2011. Factors affecting students' self-efficacy in higher education. *Educational research review* 6, 2 (2011), 95–108.

[110] John Venable, Jan Pries-Heje, and Richard Baskerville. 2016. FEDS: a Framework for Evaluation in Design Science Research. *European Journal of Information Systems* 25, 1 (January 2016), 77–89. DOI:https://doi.org/10.1057/ejis.2014.36

[111] Lev Semenovich Vygotsky and Michael Cole. 1978. *Mind in society: Development of higher psychological processes*. Harvard university press, Cambridge, MA.

[112] Thiemo Wambsganss, Matthias Soellner, and Jan Marco Leimeister. 2020. Design and Evaluation of an Adaptive Dialog-Based Tutoring System for Argumentation Skills. *ICIS 2020 Proceedings* (December 2020).

[113] Thiemo Wambsganss, Florian Weber, and Matthias Söllner. 2021. Designing an Adaptive Empathy Learning Tool. In *Wirtschaftsinformatik 2021 Proceedings*.

[114] Natalie Wellnhammer, Mateusz Dolata, Susanne Steigler, and Gerhard Schwabe. 2020. Studying with the Help of Digital Tutors: Design Aspects of Conversational Agents that Influence the Learning Process. In *Proceedings of the 53rd Hawaii International Conference on System Sciences*.

[115] Lena Wessel. 2015. Ausgewählte Ansätze zur Sprachförderung im Fach. Fach- und sprachintegrierte Förderung durch Darstellungsvernetzung und Scaffolding: Ein Entwicklungsforschungsprojekt zum Anteilbegriff (2015), 29–86.

[116] Rainer Winkler, Sebastian Hobert, Antti Salovaara, Matthias Söllner, and Jan Marco Leimeister. 2020. Sara, the Lecturer: Improving Learning in Online Education with a Scaffolding-Based Conversational Agent. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*.

[117] Sebastian Wollny, Jan Schneider, Daniele Di Mitri, Joshua Weidlich, Marc Rittberger, and Hendrik Drachsler. 2021. Are We There Yet? - A Systematic Literature Review on Chatbots in Education. *Frontiers in Artificial Intelligence* 4 (July 2021), 654924. DOI:https://doi.org/10.3389/frai.2021.654924

[118] Jacqueline Wong, Martine Baars, Min He, Björn B. de Koning, and Fred Paas. 2021. Facilitating goal setting and planning to enhance online self-regulation of learning. *Computers in Human Behavior* 124 (November 2021), 106913. DOI:https://doi.org/10.1016/j.chb.2021.106913

[119] David Wood, Jerome S Bruner, and Gail Ross. 1976. The role of tutoring in problem solving. *Child Psychology & Psychiatry & Allied Disciplines* (1976).

[120] Jiaqi Yin, Tiong-Thye Goh, Bing Yang, and Yang Xiaobin. 2021. Conversation Technology With Micro-Learning: The Impact of Chatbot-Based Learning on Students' Learning Motivation and Performance. *Journal of Educational Computing Research* 59, 1 (March 2021), 154–177.

[121] Ramazan Yılmaz and Hafize Keser. 2017. The Impact of Interactive Environment and Metacognitive Support on Academic Achievement and Transactional Distance in Online Learning. *Journal of Educational Computing Research* 55, 1 (March 2017), 95–122. DOI:https://doi.org/10.1177/0735633116656453

[122] Zamzami Zainuddin, Muhammad Shujahat, Hussein Haruna, and Samuel Kai Wah Chu. 2020. The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. *Computers & Education* 145 (February 2020), 103729. DOI:https://doi.org/10.1016/j.compedu.2019.103729

[123] Barry J Zimmerman. 1989. Models of self-regulated learning and academic achievement. In *Self-regulated learning and academic achievement: Theory, research, and practice*. Springer, 1–25.

[124] Barry J. Zimmerman. 2013. From Cognitive Modeling to Self-Regulation: A Social Cognitive Career Path. *Educational Psychologist* 48, 3 (July 2013), 135–147. DOI:https://doi.org/10.1080/00461520.2013.794676

A APPENDICES

A.1 Interview Guide

Key questions	Follow-up questions	Checklist for further follow-up questions
	Role of the PCA (10-15 minutes)	
- What should a PCA absolutely have or be able to do in order to promote your motivation? - What should a PCA avoid doing in order for you not to be demotivated? -Imagine a PCA personally supporting you in your learning: How should the PCA act towards you? - How should the PCA not perform?	- If the PCA could take on one of the roles defined in the material, which one would help you and why? - How could the PCA be designed so that it can take on multiple roles?	- Identify preferences for the role of the PCA - Do learners prefer to have multiple PCA roles for different application scenarios? - What game dynamics are already implied by the interviewees?
	Gamification design for PCAs (20 Minutes)	
- What difficulties do you have when you want to motivate yourself to learn? In which situations do you have difficulties and why? - How could game elements in PCA be used to motivate you?	- How could game elements be used in PCA, to make you feel competent? to evoke a sense of achievement in you? to grab your attention? to keep your attention? to make you feel satisfied? - How should the game element [X according to Schöbel et al. [97] work/be designed? Why? - To what extent do the game elements you mentioned fit the role of the PCA you mentioned? And how could they be used in the context of the role? - To what extent could game elements be combined with each other? And how should this combination be designed? - What elements should definitely not be included or would demotivate you? - How might others be motivated by this? And how should the PCA consider this? - What would have to be done for you not to be demotivated by them?	- Identify potentially motivating game elements - Ask reasons for users perception toward the game elements - How should the game elements work in the learning context? - Is the combination of gamification elements helpful? - Identify poor game design options - Which game elements fit to which role of the PCA?
	Social, playful learning (10 Minutes)	
- How should a PCA learn together with you playfully? - How could a PCA support the playful learning together with your peers?	- How could a PCA support the playful learning together with your peers? - How should a PCA learn together with you playfully?	- How should the PCA help you to learn together with the PCA playfully? - How should the PCA help you to structure your learning? - How do you use learning techniques and what are your experiences with them? - How might a PCA support you in the application of learning techniques? - What role should the PCA play here? - Which game elements would support and/or motivate you in social learning?

A.2 User Stories Mapped to Game Elements According to the Taxonomy of Schöbel et al. [97]

US ID	User Story	Game Elements
US1	As a user, I would like the PCA to inform me about my learning progress so that I can assess my level of knowledge and be sure that I have not missed any learning content.	Progress bar, points, badges
US2	As a user, I would like the PCA to highlight short-, medium-, and long-term milestones to keep me motivated throughout the learning process.	Points, goals, level, virtual goods
US3	As a user, I would like to be informed and rewarded by the PCA when I reach special achievements or milestones, so that I am aware of my successes.	Awards, virtual goods
US4	As a user, I would like to be quizzed by the PCA at the end of chapters or learning units so that I know I can recall what I have learned and make progress in my learning.	Quiz
US5	As a user, I would like the PCA to enable to start a quick quiz to spontaneously test my knowledge.	Quiz
US6	As a user, I would like the PCA to first teach me the new knowledge as a tutor and then feedback me as a mentor. Overall, the PCA should accompany me as a motivator.	Quiz, feedback/information
US7	As a user, I would like to be able to repeat learning content together with the PCA while the PCA provides me with a summary and then gives me a quiz.	Quiz
US8	As a user, I would like the PCA to suggest goals at the beginning of a topic or to let me define them myself, so that I feel autonomous and that I can incorporate my interests.	Goals, feedback/information
US9	As a user, I would like to compare my progress over time or measure it relative to requirements that I have established with the PCA to be able to reflect on my process.	Goals
US10	As a user, I would like to be reminded by the PCA about my progress on short-, medium- and long-term goals and be rewarded, so I have something to work towards.	Goals, level, points, badges, virtual goods
US11	As a user, I would like the PCA to confront me with learning situations that are relevant to my life, so that I can apply my knowledge to real-life problems.	Narrative
US12	As a user, I would like the PCA to introduce the narrative and divide it into several challenges, so that I can continuously progress.	Narrative, goals
US13	As a user, I would like to influence the narrative based on my activities and decisions to solve challenges on my own.	Narrative
US14	As a user, I would like the PCA to connect me with other classmates so that the PCA can act as a moderator to encourage exchange between my classmates and me.	Feedback/Information
US15	As a user, I would like the PCA to challenge me and my fellow students in common and reward us for successes so that we can learn collaboratively.	Quiz, narrative, points, badges, virtual goods
US16	As a user, I would like the PCA to assign me to a team competing against another team to apply my knowledge in a competition, with the winning team getting a higher reward.	Quiz, narrative, points, badges, virtual goods
US17	As a user, I would like the PCA to assign me to learning partners with a similar level of knowledge to be able to adequately test my knowledge.	Quiz

A.3 Mapping Diagram of Meta-Requirements, Design Principles, and Design Features