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Towards Gamified Conversational Agents for Self-Regulated Learning in Digital Education

Short Paper

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Abstract

Formal education like higher education oftentimes emphasized on strict non-digital setting. This approach can lead to issues during stressful times (e.g., Covid crisis) or when learners' needs in general are not considered. Moreover, these times highlighted how important self-regulated learning is and how much this capability is lacking in our educational system. To address these issues, we follow an Action Design Research approach and develop a gamified conversational agent (CA) that considers the learners' needs. We present our CA and conduct a first small-scale evaluation following a mixed-method approach. First results show that students universally liked a CA for self-regulated digital learning and many enjoyed the gamified experience which helped students to be motivated to learn. As next steps we will develop the next iteration of our CA and conduct a long-term field test at a university.

Keywords: conversational agents, gamification, digital education, action design research

Introduction

Formal education like higher education in universities oftentimes emphasizes strict lectures that are based on slides and may include exercises. While this approach is understandable from a practical perspective, the learners' needs can fall short, which can harm the learners' motivation (Deci et al. 2001). In contrast to this traditional approach to education, novel approaches have emerged that try to ease the stress on learners and steer learning in a more self-regulated direction while including additional motivational designs to foster learning processes (e.g., Hobert 2019). Particularly digital education approaches that use technology as a mediator can have a significant impact. Enabled by the continuous digitalization, educational settings that rely on technology-mediated learning (TML) have become an increasing trend that is likely to continue and increase (Andel et al. 2020). In general, TML can be defined as a socio-technical approach to education that, on the one hand, relies on technology as a mediator and, on the other hand, considers the learners' needs more carefully than traditional learning approaches (Gupta and Bostrom 2009). TML allows learners to learn in a self-regulated manner independent of place and time, thus putting less stress on learners and respecting the learners' needs for autonomy. The importance and value of TML that translates to a self-regulated approach to digital education was vividly highlighted during the COVID-19 crisis that struck the world in 2020, which many recent studies support (Lockee 2021). Similarly, recent studies in which students have been questioned suggest that TML has the potential to help motivate students and learn more efficiently during difficult situations like the COVID-19 crisis (Yates et al. 2021).

However, at the same time, the pandemic crisis also highlighted that our capabilities for self-regulated learning and TML may not be sufficient. Many existing TML applications can oftentimes fail to motivate and to engage learners, or they do not provide enough information or feedback when required. Moreover, learners are often not appropriately assisted or guided (Wellnhammer et al. 2020). Thus, learners may feel like they are left entirely on their own, which from a cognitive perspective can be problematic as it puts additional stress on the learners (Hobert 2019; Hobert and Meyer von Wolff 2019). This in turn may result in less satisfying academic results, failure and spiraling out of control. Consequently, it is becoming increasingly relevant to assist learners in their self-regulated learning processes (Almahri et al. 2019), for instance, by providing additional assistance like feedback. Therefore, the learners' needs should be considered to support self-regulated learning that provides assistance for learners and keeps them motivated and engaged in their learning tasks while not putting unnecessary stress on the learners.

To support learners, human tutors that provide assistance, information and feedback are used, especially in higher education. However, tutors are usually not attainable independent of time and place, do not respond timely and still may not solve the issue of a potential lack of motivation and engagement. Here, a potential TML approach could be found in conversational agents (CA) that can support learning processes more intently, provide assistance, motivate learners and keep them engaged in their learning activities. CAs are technological artifacts that can communicate in a human-like manner drawing on natural language. In the context of TML this transfers to CAs being enabled to resemble human tutors, but unlike their human counterparts, CA tutors can be accessed independent of time and place and provide instant responses (Hien et al. 2018). The human-like and technological characteristics of CAs in particular can present a suitable TML approach that is not tied to strict boundaries of traditional learning and thus can potentially support self-regulated learning activities in digital education. TML can provide more autonomy and assistance to learners who become less dependent on traditional learning offerings and thus could better follow a self-regulated learning process (Gupta et al. 2019; Hien et al. 2018; Luo et al. 2020). Nevertheless, the concept of CAs is still fairly novel and much research is yet to be done, especially from a socio-technical perspective, concerning the application of CAs in digital education (Maedche et al. 2019). Thus, investigating the socio-technical aspects of CA and particularly in digital education can prove as crucial for the long-term success of CAs in digital education. For one, CAs can support learners, e.g., regarding how and what learning tasks are to be used to support learners in self-regulated learning, and how to motivate and engage learners with motivational design like adding gamification to the CA. Therefore, we raise our research questions (RQ):

RQ1: *How should CAs be designed to better support learners in self-regulated learning activities?*

RQ2: *How should CAs be designed to better engage and motivate learners in self-regulated learning?*

To answer our RQ we engage in a long-term action design research (Sein et al. 2011) project where we iteratively develop and evaluate a gamified CA tutor.

Related Research

Two concepts are relevant for our research: gamification and CAs. CAs refer to advanced computer programs that use natural language and artificial intelligence to interact and communicate with their users (Knote et al. 2021). CAs convey a human-like experience (Hauswald et al. 2016). These characteristics enable CAs to function as social actors (Feine et al. 2019), for example, as a tutor. Depending on the modality, CAs can have different characteristics (e.g., voice based vs. text based) and include anthropomorphic features (e.g., Lembcke et al. 2020). Additionally, since CAs are computer programs, they are available independent of time and space as long as the technical boundaries are satisfied. These attributes of CAs make them a popular choice for many digital applications, including digital education or TML where they can provide additional value to existing offerings or as a stand-alone offering (Gupta and Bostrom 2009). The idea of CAs is a technology-based approach to provide assistance for users or to fulfill certain user tasks (Hauswald et al. 2016). In the context of digital education and our research context specifically, this translates to assisting learners' to help them in their self-directed learning activities (e.g., Hien et al. 2018; Luo et al. 2020), which reflects the TML approach by Gupta and Bostrom (2009). For instance, a tutoring CA could provide additional information for learners when queried or feedback on finished tasks, including additional learning material for further learning activities. In the context of our research, we focus on text-based CAs (i.e., chatbots). We use this approach, since it constitutes a much more practicable path to answer our RQs and provides a standardized solution that requires to be integrated within existing learning environments and learning management systems.

Gamification is a popular approach that is applied to many information systems, domains and contexts, including digital education. The idea behind gamification is to use so-called game design elements that originated from games and transfer them to a non-gaming context to increase motivation in users of a system (Deterding et al. 2011). Gamification can enable CAs to further motivate users (i.e., learners) by using game design elements, like rewards, for instance (Hamari et al. 2014; Yildirim 2017). Moreover, in a traditional face-to-face setting, it is usually the tutor or teacher who motivates learners. By using a CA and leveraging the CA's human-like interaction characteristics, the CA is now delegated this task and in combination with gamification can motivate learners to engage in learning activities. This approach can turn self-directed learning into a more enjoyable, motivating and engaging experience that gives autonomy to learners while enabling them to engage in learning activities (Almahri et al. 2019; Kim et al. 2018a, 2018b). Particularly motivation is a crucial topic to consider when designing applications that deal with tasks that may be perceived as boring (Brandtzaeg and Folstad 2018). In education, many students may perceive learning as a tedious task. Thus, we emphasize the importance of keeping learners engaged, motivated and, generally speaking, in a "flow" that does not stress or bore them (Csikszentmihalyi 2013).

Similar to analogous or non-conversational digital learning settings, the specificities of the learning content and setting, for example, what learning goals and cognitive dimensions are expected, need to be defined (Kang and Santhanam 2003). Moreover, because a CA is included in the concept, the CA needs to be aligned with the educational setting and the environment. This is essential because of the differences between rather simple basic and factual knowledge lessons and more complex ones that require a higher degree of cognition from the learner (Janson et al. 2020). Therefore, Anderson et al. (2001) and the cognitive learning goal dimensions can be used to design the learning tasks and support that will form the basis for a tutoring CA. The learning goal dimensions range from *remembering* (i.e., basic factual knowledge) to *applying* knowledge and *designing* novel things with learned knowledge (Anderson et al. 2001; Bloom 1956). For instance, learning the basic vocabulary of a language (i.e., *remember*) may have significantly different requirements than complex argumentative learning tasks. This is also important to provide a certain flow in the self-regulated learning activities of learners to keep them motivated and engaged. Due to the diverse nature of learners, some may become demotivated or disengaged even easier if the learning experience is not designed well, which can affect disadvantaged or underperforming learners in particular (Ames 1992). In this regard, a CA can help learners in their self-regulated learning activities in a diverse range of tasks, from a conversational vocabulary trainer to applying and transferring learned knowledge to more complex settings that require a higher level of cognitive abilities. For example, the CA may act as a tutor that offers the learner certain quizzes that allow them to check their learning progress and if needed provide additional information or feedback (Benner et al. 2021b; Benner et al. 2022). To motivate students, the CA may also present learners with rewards like collectible badges or special achievements (Hakulinen et al. 2015).

Research Approach and Methodology

For our general research approach we use action design research (ADR) as introduced by Sein et al. (2011) (see Figure 1).

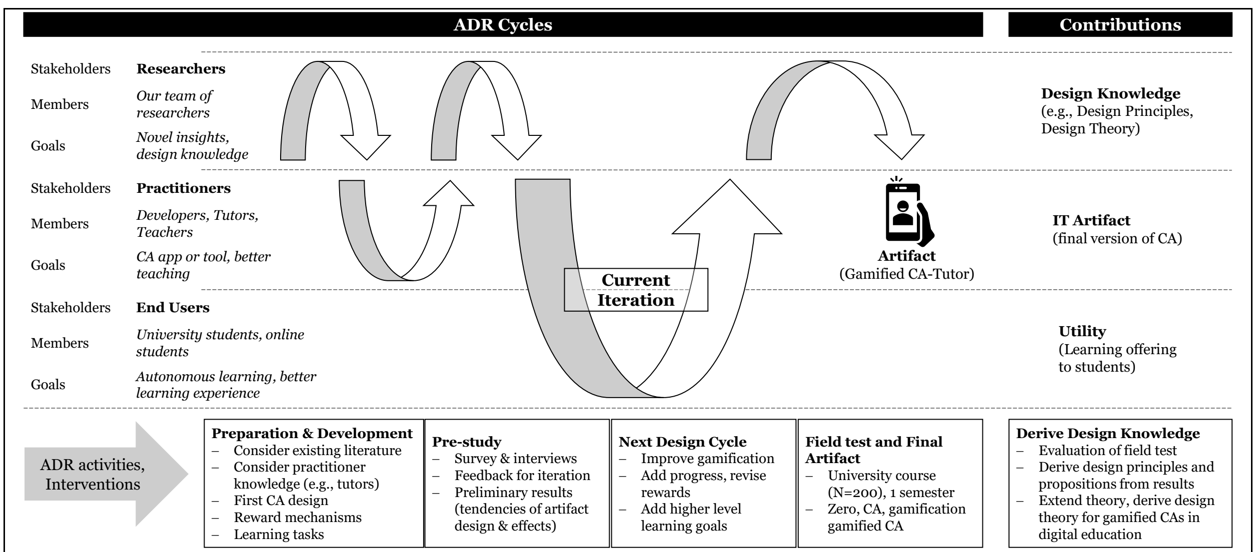

Figure 1. IT-Dominant Action Design Approach (adapted from Sein et al. 2011)

ADR is concerned with addressing a practical concern of people in a specific context with an unresolved issue to which a solution is to be found that encompasses certain measures or interventions. ADR follows three interwoven phases that consider the actors needs by actively including them in the whole process from the development to the evaluation of the final artifact. Because we emphasize the creation of an innovative technological solution, we focus on the IT-dominant variant of ADR (Sein et al. 2011). In prior iterations we have investigated related research and built a knowledge foundation from which we draw in continuous iterations (e.g., Benner et al. 2021a; Benner et al. 2021b; Benner et al. 2021c; Benner et al. 2022). Our ADR project and research is set in the context of higher education. Thus, our end users are students at a university, where we also integrate and evaluate our artifact in the existing educational landscape. Practitioners consist of two groups: CA developers and, university tutors or teachers who create and teach the university classes. The ADR process encompasses three major steps (Sein et al. 2011): (1) the problem formulation, (2) the conceptualization of the research, and (3) the build–intervention–evaluation cycle (BIE). In our article we have covered the first two steps in the former sections of our article and instead focus on the BIE part, specifically the first in-field pre-study, the following development iteration and planned next steps. To design our prototype, we have considered related research and experiences from our practitioner team. As a consequence, our prototype focuses on the lower-level learning goal dimensions (Anderson et al. 2001) such as remembering knowledge using multiple-choice and single-choice quizzes.

For the gamification design of our prototype we focus on reward mechanisms such as badges or achievements that learners can earn to complete learning tasks. Rewards are given on the basis of the quantity of learning tasks done and the quality of the answers given by learners. For instance, persistent learning, number of full lessons finished, milestones, selected on the basis of results from prior iterations and literature that highlights their effectiveness while not having much potential for negative outcomes depending on the user type e.g., time pressure or competition (Benner et al. 2021c). Additionally, the CA provides feedback and information concerning the learning tasks and answers to learners.

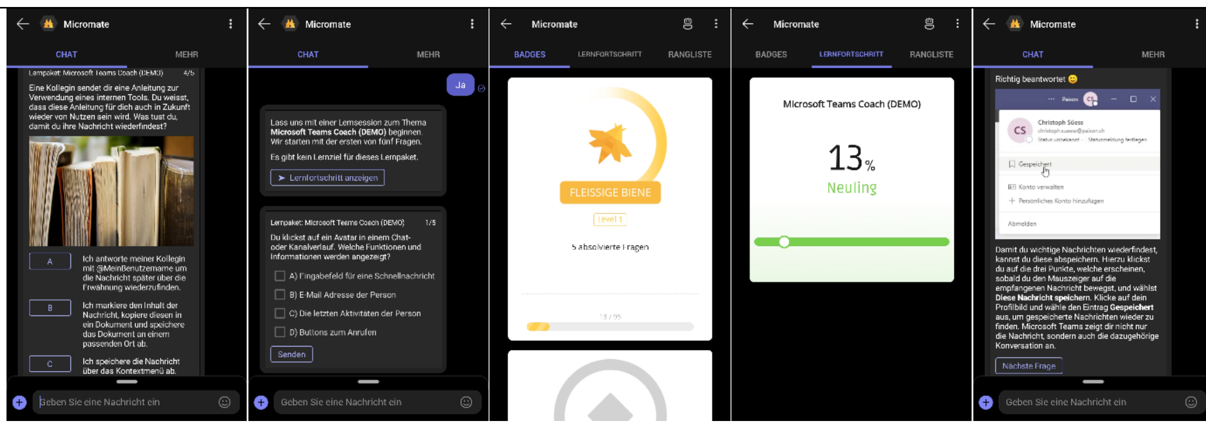

Figure 2. Prototype screenshot selection

The official prototype[1] can be seen in Figure 2. From left to right or 1st to 5th the figure depicts two tasks (1st single choice, 2nd multiple choice) and game design elements (3rd badges, 4th progress, 5th information given after an answer).

We evaluate the prototype in a small-scale setting with the intended end-user group. To evaluate our first prototype, we follow a hybrid/mixed-method approach with a small-scale survey (n=20) and interviews (n=5). We draw on existing scales from literature to construct our survey. As answer options we refer to a 5-point Likert scale (Likert 1932). The questionnaire is built around what we have determined to be the learners' needs for self-regulated digital learning from both theory and practice. Thus, we include the following concepts: extrinsic motivation (ME), intrinsic motivation (MI), performance (MK), interest (MS) to cover base motivational factors. Next, we include autonomy (SA), competency (SC) and relatedness (SR) based on self-determination theory (Deci and Ryan 2000). We also include concepts related to trust including confidence (TC), dependability (TD), functionality (TF), helpfulness (TH) and reliability (TR).

[1] https://micromate.ai/faq note this prototype is available in Germany only and already more advanced

Moreover, we include the concepts of playfulness (GD), CA experience (CAX) and intention to use (AN). Additionally, we include our own learning task (LC) construct to see if the students found the task to be understandable or doable, which we base on Anderson et al. (2001). All constructs and sources can be found in Table 1. Because of the small scope of our pre-study, we focus on descriptive statistics, Cronbach's Alpha (Cronbach 1951), composite reliability (Cho 2016) and one-sample t test for the scale mean (mu = 3) as measures for our survey. For the interviews we follow a semi-structured interview approach (Opdenakker 2006) including similar but adapted questions from our survey. We formulated our questions in a generic and easy-to-answer manner so that our participants were able to easily provide feedback for us without limiting them in giving us an answer. Following this pre-study evaluation, we further develop our prototype artifact based on the findings. Ultimately, we will field-test our resulting prototype artifact in a semester-long field test using university students in a comparable setting from our pre-study. We target a larger sample size (ca. n=200) for our evaluation. Analogous to our pre-study evaluation we continue with our hybrid–mixed method approach. We will use an experimental approach to manipulate our gamification concept for the CA prototype to then analyze if gamification can support better learning outcomes.

Preliminary Findings and Discussion

In this section we present the preliminary findings of the first evaluation of our prototype (Table 1).

Construct	Source(s)	Mean	SD	CA	CR	t(df)
Extrinsic Mot. (ME)	Pintrich (1991)	2.98	1.21	0.872	0.877	t = -0.120; p = 0.905
Intrinsic Mot. (MI)	Plant and Ryan (1985)	4.31	0.64	0.895	0.899	t = 10.684; p < 0.001***
Performance (MK)	Vos et al. (2011)	3.81	0.76	0.797	0.813	t = 7.279; p < 0.001***
Interest (MS)		4.37	0.65	0.813	0.827	t = *11.105*; p < 0.001***
Effort (MA)		3.21	1.24	0.674	0.611	t = 1.576; p = *0*.132
Autonomy (SA)	Deci and Ryan (2000)	4.06	0.75	0.794	0.810	t = 8.300; p < 0.001***
Competency (SC)		4.10	0.73	0.845	0.849	t = 8.543; p < 0.001***
Relatedness (SR)		3.08	0.95	0.887	0.890	t = 0.413; p = 0.684
Confidence (TC)	Dietvorst et al. (2015)	3.88	0.63	0.728	0.766	t = 7.571; p < 0.001***
Dependability (TD)	McKnight et al. (2020)	3.77	0.93	0.929	0.936	t = 4.023; p = 0.001***
Functionality (TF)	McKnight et al. (2011)	3.83	0.86	0.810	0.830	t = 5.000; p < 0.001***
Helpfulness (TH)		3.62	0.79	0.719	0.729	t = 4.294; p < 0.001***
Reliability (TR)		3.95	0.71	0.926	0.927	t = 6.435; p < 0.001***
Playfulness (GD)	Hamari and Koivisto (2015)	3.65	0.92	0.830	0.831	t = *3.711*; p = 0.001***
Learning Task Clarity (LC)	*Own based on Anderson et al. (2001) for learning tasks*	4.09	0.73	0.906	0.916	t = 7.257; p < 0.001***
CA experience (CAX)	Agarwal and Karahanna (2000)	3.19	1.05	0.869	0.873	t = 1.071; p = 0.298
Intention to use (AN)	Davis (1989)	3.15	0.98	0.894	0.904	t = 0.730; p = 0.474

SD = standard deviation; CA = Cronbach's Alpha (calculated with R and psych package); CR = Composite reliability (calculated with R and lavaan package)
All constructs and items were measured using a 5-point Likert scale (Likert 1932). All constructs and items are ordered from 1 (low/disagree) to 5 (high/agree)
*Single-sample t test was done for scale mean (mu = 3) at t(df) = N-1 = 19 using R and standard library; significance with * p ≤ 0.05; ** p ≤ 0.01; *** p ≤ 0.001;*

Table 1. Survey Results

We also include a tested p value to investigate tendencies based on our survey. We then underpin our survey results with the results of our interviews, including citations and statements of our participants, and briefly discuss them afterwards. First, we calculate the reliability of our results using CA and CR. Here, we have found that all but two of our constructs measure with satisfactory reliability above 0.70 and below 0.95 (Hair et al. 2021). For the two constructs that measured below 0.7 (MS, GD) we have removed the item that differed noticeably from other items and had much higher loadings. Regardless, we may have to revise these constructs for our field-test evaluation. Furthermore, while we see that no construct measures higher than 0.95 CR, AN, TD, TR and LC measure at or above 0.90, which can indicate redundancy and reduced construct validity (Diamantopoulos et al. 2012), thus requiring potential revision as well. According to our data all constructs measure with satisfactory to good reliability and can be accepted (Hair et al. 2021). SD values show that the highest mean measured is for MI at 4.31 and MS at 4.37, whereas the lowest is ME at 2.98. In this context it is also notable that only few constructs have a high SD (ME = 1.21; MA 1.24), whereas the majority is at or below an SD of 1.0. Concerning the significance of our small sample results, we find that all results but ME, MA, SR, CAX and AN are significant at a level of p = 0.001 or better. Thus, our results highlight potentially significant effects of our gamified tutoring CA prototype on the self-directed learning.

To consider differences resulting from a small sample size, we underpin the results from our survey with insights from interviews with students. Our students liked that the CA offers them the means to learn whenever and wherever they wanted. This reflects the high rating and significance of the related constructs from our survey (e.g., autonomy/SA). For instance, a subject reported, *"I very much liked the bot as a daily learning companion for independent self-studying"*. Also, students stated that during commutes the playful learning (i.e., GD) with the CA was a welcome way to spend time. A student said that *"I really liked to use the CA on my way to campus or in the evening in front of the TV. You can just learn on the side instead of doing nothing"*. Another student stated that *"to gather badges was really cool and motivating, it was good fun"*. Students liked to gather badges and achievements that they found to be motivating, which relates to our reported figures for motivation. However, we also received criticism from our students, since not everyone enjoyed the gamified experience. Students expressed their desire for more guidance, overview of their learning progress and general tracking of their learning process. Students stated that *"more guidance [i.e., current progress, answer quality] would be cool, maybe some kind of dashboard that allows an overview of my learning progress and the badges I have earned"*. Particularly, game design elements that refer to the mechanism of progress were mentioned often: *"badges are kind of random and don't follow any structure or progress, I would really like to see and get something that reflects my progress"*. Therefore, we will include progress elements in our next iteration of our artifact prototype. We assume that in our field test, this will result in a higher score for GD and less variance.

Our own construct (LC) suggests that our learning tasks are easily understandable, have a clear goal and are received positively by our students. Further, students particularly like the information and feedback on the learning tasks given by the CA and stated that *"explanations and additional material provided by the bot was very useful"* as well as *"in contrast to normal learning the bot is an excellent alternative"*. This insight reflects the results of constructs related to the competency, reliability and helpfulness of our CA. Thus, we presume that our CA itself is generally well-developed, and only minor adjustments are necessary. Another interesting insight from the interviews is how participants compared our artifact prototype to learning apps (especially the *Quizlet* app) and traditional learning settings. Here, participants said that the dialogue-based structure of the CA was generally the preferred choice because of how the learning tasks are implemented and how easy to use the CA is: *"[the bot] is so much better than [Quizlet] because of the features and dialogue learning"* and *"I liked the chatbot more than learning groups. There's just too much distraction, and the bot offers just enough social distraction to be fun and all but not distracting"*. This finding is interesting because our CA artifact seems to fall into a zone between learning apps that are not motivational, fun or social enough and traditional learning (e.g., learning groups), which is too distracting. Furthermore, many subjects emphasized how much of an improvement a tutoring CA can be, e.g.: *"the bot is better than cards or slides where there's not enough support [i.e., information/feedback] and learning groups that can be very distracting"*. In general, our students universally liked the idea of a tutoring CA and enjoyed the learning experience using our prototype, according to our interviews. On the flipside, SR, CAX and AN measure relatively low compared to our other constructs. With regard to SR and CAX, participants seem to not be able to relate very well to our CA artifact. Since we did not include any avatar or personalization of the CA, we assume that this could be the cause. We plan to investigate this relation by including an optional avatar figure that could make students relate to our tutor CA more closely. Concerning AN, while AN measures slightly above mid-scale, it is still relatively low. This may be related to the circumstances of our pre-study, which was only conducted over a short period of time with a small sample. Nevertheless, we will investigate this in greater detail in our field test.

Next Steps and Expected Contribution

Overall, the goal of our research is to investigate how CAs should be designed to support learners in their self-regulated learning activities (RQ1) and how to make them motivating and engaging (RQ2). To answer these questions, we engage in an ADR project and developed a prototype of a gamified CA for digital education. Our CA uses simple quizzes with learning tasks based on the lower-level learning goal dimensions of Anderson et al. (2001) and is gamified with a reward system (i.e., badges and achievements). In a first pre-study we gathered survey and interview data. This data indicates that our developed prototype, its design and the included interventions have a potentially significant positive effect on the self-regulated learning activities of students. Moreover, our interviews revealed that the CA itself is welcomed and held in high regards by our students. Nevertheless, based on the pre-study results, we can improve some aspects. In this regard, we have found out that other game design elements are desired by students, particularly progress elements (i.e., progress bar, levels). For the next iteration we expand our gamification design as suggested by our students. Moreover, we will include tasks directed at higher learning goal dimensions (e.g., analyze) to expand the scope of our tutoring CA. To evaluate the next iteration of our artifact, we will field-test the prototype in a semester-long setting with a larger sample size and power analysis (Faul et al. 2007) at a university (expected N=200). In contrast to our pre-study, we will focus on an in-depth quantitative analysis for our field test and include multiple treatments to explore design options to detangle the effects of each component against the status quo. Thus, we expect to contribute in two ways. First, we expand the knowledge space of TML, human–computer and gamification domains by deriving empirically validated design knowledge and theory (Gregor et al. 2020). Second, we contribute to practice by showcasing how a gamified tutoring CA can help learners in self-directed learning activities which – to our knowledge – is the first of its kind. Additionally, we want to highlight potential opportunities for future research in this context. While we focus on gamification, concepts like digital nudging, social cues or persuasive design in general can all have similar but different effects that may help to solve our RQs as well (Feine et al. 2019; Mirsch et al. 2017)<Anonymous et al.>. Moreover, some classes or courses may or may not be suited for CA use, for instance, statistics. While details and exercises may still require live classes with human tutors, learning the basics (e.g., when to use what method) may be supported by a CA. Limitations and preliminary findings considered, we strongly believe gamified Cas can support self-regulated learning activities of students, since it does increase motivation and is perceived as a helpful tool by our participants that can help to overcome difficult times (e.g., COVID-19) or simply be a welcome addition to the existing learning infrastructure.

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References

Agarwal, R., and Karahanna, E. 2000. “Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage,” *MIS Quarterly* (24:4), p. 665.

Almahri, F. J., Bell David, and Arzoky, M. 2019. “Augmented education within a physical space,” *UK Academy for Information Systems Conference Proceedings 2019. 45.*, pp. 1-12.

Ames, C. 1992. “Classrooms: Goals, structures, and student motivation,” *Journal of Educational Psychology* (84:3), pp. 261-271.

Andel, S. A., Vreede, T. de, Spector, P. E., Padmanabhan, B., Singh, V. K., and Vreede, G.-J. de. 2020. “Do social features help in video-centric online learning platforms? A social presence perspective,” *Computers in Human Behavior* (113), p. 106505.

Anderson, L. W., Krathwohl, D. R., and Airasian, P. W. (eds.). 2001. *A taxonomy for learning, teaching, and assessing*: *A revision of Bloom's taxonomy of educational objectives*, New York: Longman.

Benner, D., Elshan, E., Schöbel, S., and Janson, A. 2021a. “What do you mean? Recovery Strategies to Overcome Breakdowns of Conversational Agents,” *International Conference on Information Systems* (42).

Benner, D., Schöbel, S., and Janson, A. 2021b. “Exploring the State-of-the-Art of Persuasive Design for Smart Personal Assistants,” *Wirtschaftsinformatik* (16).

Benner, D., Schöbel, S., and Janson, A. 2021c. “It is only for your own good, or is it? Ethical Considerations for Designing Ethically Conscious Persuasive Information Systems,” *Americas Conference on Information Systems* (27).

Benner, D., Schöbel, S., Suess, C., Baechle, V., and Janson, A. 2022. “Level-Up your Learning - Introducing a Framework for Gamified Educational Conversational Agents,” *Wirtschaftsinformatik* (17).

Bloom, B. S. 1956. “Taxonomy of educational objectives: The classification of educational goals,” *Cognitive domain*.

Brandtzaeg, P. B., and Folstad, A. 2018. “Chatbots: changing user needs and motivations,” *interactions* (25:5), pp. 38-43.

Cho, E. 2016. “Making Reliability Reliable,” *Organizational Research Methods* (19:4), pp. 651-682.
Cronbach, L. J. 1951. “Coefficient alpha and the internal structure of tests,” *Psychometrika* (16:3), pp. 297-334.
Csikszentmihalyi, M. 2013. “Finding Flow: The Psychology of Engagement With Everyday Life,” *Psychology Today*.
Davis, F. D. 1989. “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology,” *MIS Quarterly* (13:3), p. 319.
Deci, E. L., Koestner, R., and Ryan, R. M. 2001. “Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again,” *Review of Educational Research* (71:1), pp. 1-27.
Deci, E. L., and Ryan, R. M. 2000. “The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior,” *Psychological Inquiry* (11:4), pp. 227-268.
Deterding, S., Dixon, D., Khaled, R., and Nacke, L. 2011. “From Game Design Elements to Gamefulness: Defining "Gamification",” *Proceedings of the 15th International Academic MindTrek Conference Envisioning Future Media Environments*, pp. 9-15.
Diamantopoulos, A., Sarstedt, M., Fuchs, C., Wilczynski, P., and Kaiser, S. 2012. “Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective,” *Journal of the Academy of Marketing Science* (40:3), pp. 434-449.
Dietvorst, B. J., Simmons, J. P., and Massey, C. 2015. “Algorithm aversion: people erroneously avoid algorithms after seeing them err,” *Journal of experimental psychology. General* (144:1), pp. 114-126.
Faul, F., Erdfelder, E., Lang, A.-G., and Buchner, A. 2007. “G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences,” *Behavior research methods* (39:2), pp. 175-191.
Feine, J., Gnewuch, U., Morana, S., and Maedche, A. 2019. “A Taxonomy of Social Cues for Conversational Agents,” *International Journal of Human-Computer Studies* (132), pp. 138-161.
Gregor, S., Chandra Kruse, L., and Seidel, S. 2020. “The Anatomy of a Design Principle,” *Journal of the Association for Information Systems* (Forthcoming).
Gupta, S., and Bostrom, R. 2009. “Technology-Mediated Learning: A Comprehensive Theoretical Model,” *Journal of the Association for Information Systems* (10:9), pp. 686-714.
Gupta, S., Jagannath, K., Aggarwal, N., Sridar, R., Wilde, S., and Chen, Y. 2019. “Artificially Intelligent (AI) Tutors in the Classroom: A Need Assessment Study of Designing Chatbots to Support Student Learning,” *PACIS 2019 Proceedings*.
Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., and Ray, S. 2021. *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook*, Cham: Springer International Publishing; Imprint Springer.
Hakulinen, L., Auvinen, T., and Korhonen, A. 2015. “The Effect of Achievement Badges on Students’ Behavior: An Empirical Study in a University-Level Computer Science Course,” *International Journal of Emerging Technologies in Learning (iJET)* (10:1), p. 18.
Hamari, J., and Koivisto, J. 2014. “Measuring flow in gamification: Dispositional Flow Scale-2,” *Computers in Human Behavior* (40), pp. 133-143.
Hamari, J., and Koivisto, J. 2015. “Why do people use gamification services?” *International Journal of Information Management* (35:4), pp. 419-431.
Hamari, J., Koivisto, J., and Sarsa, H. 2014. “Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification,” in *2014 47th Hawaii International Conference on System Sciences,* Waikoloa, HI. 06.01.2014 - 09.01.2014, IEEE, pp. 3025-3034.
Hauswald, J., Laurenzano, M. A., Zhang, Y., Yang, H., Kang, Y., Li, C., Rovinski, A., Khurana, A., Dreslinski, R. G., Mudge, T., Petrucci, V., Tang, L., and Mars, J. 2016. “Designing Future Warehouse-Scale Computers for Sirius, an End-to-End Voice and Vision Personal Assistant,” *ACM Transactions on Computer Systems* (34:1), pp. 1-32.
Hien, H. T., Cuong, P.-N., Le Nam, N. H., Nhung, Ho Le Thi Kim, and Le Thang, D. 2018. “Intelligent Assistants in Higher-Education Environments: The FITEBot, a Chatbot for Administrative and Learning Support,” *ACM SoICT Proceedings*, pp. 69-76.
Hobert, S. 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*, H. Krcmar and J. Fedorowicz (eds.), Munich, Germany, AIS, pp. 1-17.
Hobert, S., and Meyer von Wolff, R. 2019. “Say Hello to Your New Automated Tutor – A Structured Literature Review on Pedagogical Conversational Agents,” Siegen, Germany, pp. 301-314.

Janson, A., Söllner, M., and Leimeister, J. M. 2020. "Ladders for Learning: Is Scaffolding the Key to Teaching Problem-Solving in Technology-Mediated Learning Contexts?" *Academy of Management Learning & Education* (19:4), pp. 439-468.

Kang, D., and Santhanam, R. 2003. "A Longitudinal Field Study of Training Practices in a Collaborative Application Environment," *Journal of Management Information Systems* (20:3), pp. 257-281.

Kim, S., Song, K., Lockee, B., and Burton, J. 2018a. "Engagement and Fun," in *Gamification in Learning and Education*, S. Kim, K. Song, B. Lockee and J. Burton (eds.), Cham: Springer International Publishing, pp. 7-14.

Kim, S., Song, K., Lockee, B., and Burton, J. 2018b. "What is Gamification in Learning and Education?" in *Gamification in Learning and Education*, S. Kim, K. Song, B. Lockee and J. Burton (eds.), Cham: Springer International Publishing, pp. 25-38.

Knote, R., Janson, A., Söllner, M., and Leimeister, J. M. 2021. "Value Co-Creation in Smart Services: A Functional Affordances Perspective on Smart Personal Assistants," *Journal of the Association for Information Systems* (22:2), pp. 418-458.

Lembcke, T.-B., Diederich, S., and Brendel, A. B. 2020. "Supporting Design Thinking Trough Creative and Inclusive Education Facilitation: The Case of Anthropomorphic Conversational Agents for Persona Building," *Twenty-Eigth European Conference on Information Systems*.

Likert, R. 1932. "A Technique for the Measurement of Attitudes," *Archives of Psychology* (140), pp. 5-55.

Lockee, B. B. 2021. "Online education in the post-COVID era," *Nature Electronics* (4:1), pp. 5-6.

Luo, C. J., Wong, V. Y. L., and Gonda, D. E. 2020. "Code Free Chatbot Development," in *Proceedings of the Seventh ACM Conference on Learning @ Scale*, D. Joyner, R. Kizilcec and S. Singer (eds.), Virtual Event USA, ACM, pp. 233-235.

Maedche, A., Legner, C., Benlian, A., Berger, B., Gimpel, H., Hess, T., Hinz, O., Morana, S., and Söllner, M. 2019. "AI-Based Digital Assistants," *Business & Information Systems Engineering* (61:4), pp. 535-544.

McKnight, D. H., Carter, M., Thatcher, J. B., and Clay, P. F. 2011. "Trust in a specific technology," *ACM Trans. Manage. Inf. Syst.* (2:2), pp. 1-25.

McKnight, D. H., Liu, P., and Pentland, B. T. 2020. "Trust Change in Information Technology Products," *Journal of Management Information Systems* (37:4), pp. 1015-1046.

Mirsch, T., Lehrer, C., and Jung, R. 2017. "Digital Nudging: Altering User Behavior in Digital Environments," *International Conference on Wirtschaftsinformatik* (13), pp. 634-648.

Opdenakker, R. 2006. "Advantages and Disadvantages of Four Interview Techniques in Qualitative Research," *Forum: Qualitative Social Research (FQS)* (7:4).

Pintrich, P. R. 1991. "A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ),"

Plant, R. W., and Ryan, R. M. 1985. "Intrinsic motivation and the effects of self-consciousness, self-awareness, and ego-involvement: An investigation of internally controlling styles," *Journal of Personality* (53:3), pp. 435-449.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., and Lindgren, R. 2011. "Action Design Research," *MIS Quarterly* (35:1), pp. 37-56.

Vladova, G., Ullrich, A., Bender, B., and Gronau, N. 2021. "Students' Acceptance of Technology-Mediated Teaching - How It Was Influenced During the COVID-19 Pandemic in 2020: A Study From Germany," *Frontiers in Psychology* (12), p. 636086.

Vos, N., van der Meijden, H., and Denessen, E. 2011. "Effects of constructing versus playing an educational game on student motivation and deep learning strategy use," *Computers & Education* (56:1), pp. 127-137.

Wellnhammer, N., Dolata, M., Steigler, S., and Schwabe, G. 2020. "Studying with the Help of Digital Tutors: Design Aspects of Conversational Agents that Influence the Learning Process," *Hawaii International Conference on System Sciences 2020*, pp. 146-156.

Yates, A., Starkey, L., Egerton, B., and Flueggen, F. 2021. "High school students' experience of online learning during Covid-19: the influence of technology and pedagogy," *Technology, Pedagogy and Education* (30:1), pp. 59-73.

Yildirim, I. 2017. "The effects of gamification-based teaching practices on student achievement and students' attitudes toward lessons," *The Internet and Higher Education* (33), pp. 86-92.