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Towards Conversational Co-Creation of Learning Content in Digital Higher Education

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ABSTRACT

Today formal education like higher education relies on digital learning content like learning videos or quizzes. Using such online learning material enables students to learn independently from time and place. While improvements have been made, there are still many issues as the two-year long crisis in 2020 has revealed. Many offerings do not consider the learners' needs and can result in unsuccessful learning. One way to address these short comings is to actively include learners in the creation process of learning content. However, co-creation oftentimes relies on face to face and or group settings that may not be possible for all students at all times. Therefore, we undertake a long-term action design research project to investigate the novel concept of conversational co-creation of learning material using a conversational agent and persuasive design to engage and motivate learners. In this article we present an early-stage prototype and concept of conversational co-creation.

Keywords

Conversational agents, co-creation, digital education, action design research.

INTRODUCTION

Nowadays education often times relies on digital content such as recordings of lectures or dedicated learning videos to teach students. Some classes also include learning quizzes based on that learning material that students can use as they please. This approach allows students to follow a more self-directed or self-regulated learning (e.g., while on the bus). While this approach to digital education has gained momentum and made good progress, the two-year long Covid crisis showed us that there is still a lot of work to do (Lockee, 2021; Yates *et al.*, 2021; Triviño-Cabrera *et al.*, 2021). For instance, learning material is created without the learners' needs or concerns in mind. This can lead to learning content that is not as easily understandable or that doesn't address the learners' needs. Moreover, such distant digital education can leave students to be disengaged or demotivated. This can also lead to students postponing their learning activities and prolonged procrastination, thus lower learning efficiency when left on their own. Therefore, researchers argue and emphasize on the need to provide students with the means to support them in self-directed learning (Wellnhammer *et al.*, 2020). To address these issues there are various approaches such as motivating design, interactive learning content or directly incorporating students in the whole process. The latter approach refers to content co-creation and allows students to actively participate in creating and improving learning material to better suit their needs. This approach has already been proven to be able to improve the performance of students and engage them more effectively in the overall learning (Mai *et al.*, 2021). This means that in digital co-creation settings students may be left to their own and thus requiring more advise and instructions. A typical face-to-face co-creation setting may include broader range of tools, people and possibilities for cooperation than a digital one. Regarding the application of CAs, research highlights the potential of conversation-based co-creation (Weinert *et al.*, 2022) and first applications exist. However, they are limited in functionality and not geared towards digital higher education or incorporate learning videos (Billert *et al.*, 2020). Additionally, the aspect of engagement and motivation is not yet very well investigated and requires additional research. Thus, motivation and engagement of students may require a more support. Here, persuasive design may prove as a feasible tool to strengthen the motivation and engagement of students (Benner *et al.*, 2022a; Shevchuk *et al.*, 2019). For instance, nudging can help to push students to learn more intently while gamification offers motivational incentives to students to sustain their self-directed learning activities. In the case of co-creation this approach may help explain the students the benefits for their co-creation efforts and motivate them. To investigate this proposed novel conversational co-creation approach for learning content in higher education we therefore raise the following research question (RQ):

RQ: *How should conversational co-creation of learning content in higher education be designed?*

To address this issue, we conduct an Action Design Research (ADR) project (Sein *et al.*, 2011) and develop a first prototype for conversational co-creation of learning

content in higher education. To do so, we present a first early version of a conversational agent (CA) prototype based on raised requirements from literature and practice, including university students.

RELATED RESEARCH

Conversational agents in digital education

In general CAs refer to advanced computer programs that make use of natural language and convey a human-like experience (Knote *et al.*, 2021; Hauswald *et al.*, 2016). This experience can be conveyed using different channels (i.e., voice or text) and be enriched by including different conversational human characteristics (Lembcke *et al.*, 2020; Feine *et al.*, 2019). The general idea behind CAs is to provide assistance to users (Hauswald *et al.*, 2016), for instance provide assistance for the co-creation of learning materials. Additionally, CAs can be used independently from time, place and in most cases also the technological platform. These characteristics make CAs a popular tool in digital education and technology-mediated learning (Gupta & Bostrom, 2009; Hobert, 2019; Winkler *et al.*, 2020). Moreover, CAs have proven to be useful tool in helping students with their learning activities, helping them to advance and provide general assistance during learning activities (Hien *et al.*, 2018; Luo *et al.*, 2020). For instance, CAs can enhance students problem-solving capabilities (e.g., Janson *et al.*, 2020) and collaborative learning (e.g., Kang & Santhanam, 2003) that could prove as useful for conversational co-creation. This is also reinforced because CAs enable students to advance at their own pace in a self-directed manner (Gupta *et al.*, 2019). In the context of this research, we will focus on text-based CAs (i.e., chatbots) because of the one-to-one interaction relation between students and the CA that we intend, as well as our use case and organizational boundaries.

Co-creation in digital education

The term of co-creation can be defined in various similar ways. In general, value co-creation supports creative collaboration in any kind of social process by involving individuals in different phases of a service development process (Roser *et al.*, 2013). Generally, services can be found in each context, also allowing us to establish value co-creation for learning services and processes. In a value-co creation process in digital learning, we can involve different stakeholders such as learners and teachers or we can support a value co-creation between learners by involving them in working together for completing different group tasks and enabling them to effective and efficient collaboration (Cook-Sather *et al.*, 2014). Thus, in the context of digital education, the term co-creation can be defined as a *"collaborative, reciprocal process through which all participants have the opportunity to contribute equally, although not necessarily in the same ways, to curricular or pedagogical conceptualization, decision making, implementation, investigation or analysis"* (Cook-Sather *et al.*, 2014, pp. 6-7). Simply put, in a co-creation process in digital learning, learners are triggered to collaborate with others also enabling them to create their own learning materials (Auvinen & Oy, 2009). In such a collaborative or creative setting, learning and also learning success happens because of the learner's participation in cooperation or in the interaction with learning material. Co-creating learning materials can also lead to benefits in learning outcomes and satisfaction (Oeste-Reiss *et al.*, 2016). However, co-creation and its success heavily depend on adapting it to the needs of learners and context characteristics (Bovill *et al.*, 2016). To cover such aspects, it is important to integrate learners in the design process of learning materials, which still misses some contributions in research (Bovill *et al.*, 2016). Therefore, with this paper, we aim to shed some light on the creation of learning processes that involve the creation of learning materials by co-creation.

Learning content co-creation boundaries

In order to design quality learning content – be it analog or digital – a framework that defines boundaries and expectations should be consulted (Kang & Santhanam, 2003). Thus, it should be considered what content is to be taught and in our context co-created (e.g., basic knowledge Dokukina & Gumanova, 2020). Therefore, the learning goals should be defined first since their characteristics are related to the potential implementation of co-created material as well as the general level or dimension of content. In this regard, we draw on the cognitive learning goal dimensions framework that considers these factors and categorizes learning along several increasingly demanding learning goal dimensions (Anderson *et al.*, 2001). The base level learning goal dimension regards to the simple recollection of base concepts and knowledge, whereas the higher level dimensions require complex problem-solving skills (Bloom, 1956; Anderson *et al.*, 2001). In the context of our research, the co-creation CA can draw on learning goal dimensions to recommend suitable question types and provide examples. This way, students can be enabled to create content-appropriate learning material that fits the learning goals (e.g., learning base knowledge of a course).

RESEARCH APPROACH

For our general research approach (see figure 1) we follow ADR as introduced by Sein *et al.* (2011). In general, ADR is concerned with developing solutions for practical problems of people in a specific context where an unresolved issue exists. To develop a solution, ADR follows continuous three phase cycle that includes researchers, practitioners and end-users in the developmental process from conceptualization to final evaluation. In our case we focus on the organizational dominant variant of ADR because of the tight relation to university organizational processes for digital education. ADR in general follows three major steps: the problem formulation, the conceptualization of research and the build-intervention-evaluation cycle.

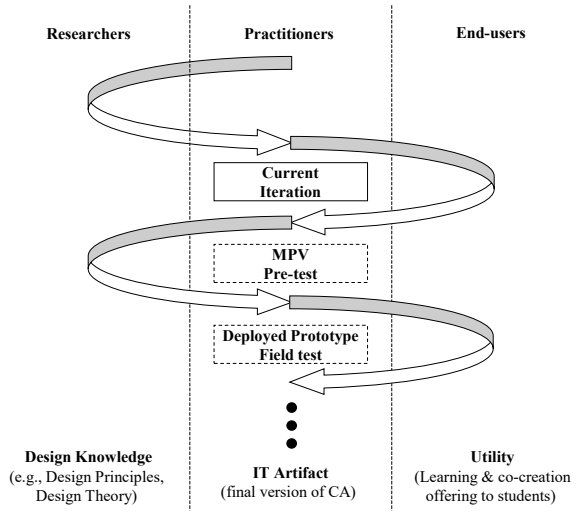

Figure 1. ADR approach (following Sein *et al.*, 2011)

In this article we focus on the conceptualization and early-stage build steps, after we have presented the problem formulation in the introduction. 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. The student base for our evaluation will be primarily early to mid-stage bachelor students for this iteration. We plan to transfer our prototype to more advanced topics and master students eventually. Our first step was to consider relevant literature that we have incorporated in our related research section and the learners' needs from conducted field investigation. In particular, we have questioned students about their needs, let them construct a persona and learning journey, as well as describe how or where they require additional material or can even contribute themselves. We describe these findings in the following section.

CONVERSATIONAL CO-CREATION CONCEPT

In this section we first conceptualize our novel conversational co-creation approach. We then present the requirements from practice that we gathered from university students and how we integrate our artifact in the existing educational landscape. Lastly, we present the co-creation CA itself. The basic concept for conversational co-creation can be seen in figure 2. The students or general learners interact with the embedded CA and by doing so can provide input for new learning content. This input can be simple questions or remarks where students do not understand a topic, voice their need for additional support or even some content they have created on their own. Especially the latter is encouraged during CA interaction where students can create simple single or multiple-choice quizzes based on the learning content they have interacted with (e.g., a learning video).

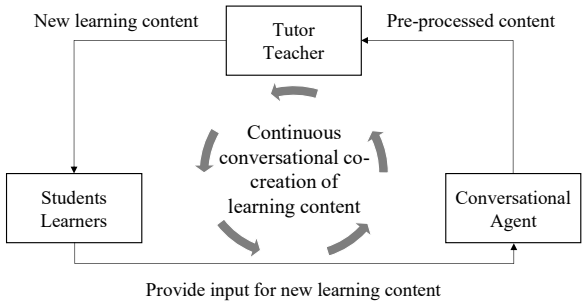

Figure 2. Proposed solution concept

In this case, the CA can provide instructions and support for co-creating novel content. This content is then pre-processed and prepared for a human tutor to curate and derive novel learning content from to ensure quality and correctness.

Requirements for a conversational co-creation

In order to develop our early-stage prototype we first consulted a group of end users i.e., university students (n = 34), considered organizational requirements of the university as well as technical limitations. From these insights we have derived a set of requirements from users (U#), from literature (L#), the organization (O#) and from a technological (T#) point of view (see tables 1-4). Additionally, students were asked to construct a persona and learning journey.

User requirements

Almost all of the 34 students we asked voiced their need for an easy-to-use solution that does not require any learning to use (U1). Thus, the resulting artifact must be intuitive and ready to use without a prior tutorial. Similarly, the vast majority of students would find a CA immensely useful that could supply them with additional material for things they do not fully understand or wish to learn more about (U2). Many students mentioned examples like additional links to videos, definitions, (practice/industry) examples and related course material. Students who commented on co-creation specifically revealed that they would need a CA that explains to them how good content should look like i.e., what question types, when, where and how to use including practical examples. This case is also illustrated in figure 4. Another finding related to U2 is that many students are afraid of asking the wrong questions i.e., questions that may seem "stupid" which may negatively influence the teacher's perception of the student. Here, many students would very much prefer to ask a CA such questions. Next, the majority of students also mentioned that the CA should be motivating, encouraging or engaging (U3) as they perceive learning as bothersome or boring at times. Some also specified designs they would welcome to see such as rewards or progress. Particularly points and progress bar design elements were mentioned by students. Additionally, many students also expressed their desire for checking their learning progress using CA. Student

examples include single or multiple-choice quizzes, free-text questions and pre-exam training in this context (U4). These findings are in line with recent research on pedagogical CAs (e.g., Benner *et al.*, 2022a; Benner *et al.*, 2022b; Hobert & Meyer von Wolff, 2019).

Lastly, some students also mentioned that the CA should be robust and able to recover from errors. This requirement stems from negative past experiences with CAs the students had. As example, students mentioned cases where the CA doesn't know the answer and as consequences hands the situation to a qualified tutor. This hand-over strategy can also be found in recent research (e.g., Benner *et al.*, 2021; Poser *et al.*, 2021).

##	Description
U1	No learning curve, easy to learn and use (i.e., no tutorial required)
U2	CA should provide helpful information (e.g., links, examples, etc.)
U3	CA should be encouraging, engaging and motivating to use
U4	CA should enable students to learn and test their knowledge (e.g., quizzes, tests)
U5	CA should be able to recover from errors or issues (e.g., doesn't know the answer)

Table 1. User requirements

Requirements from related research

The two most significant findings for conversational co-creation and related CA design are reflected in L1 and L2. When co-creating learning content, the targeted learning goal dimension should be clearly outlined (L1). Depending on the content, content type and intended goal the dimensions will translate into different results. For instance, the basic course depicted in figure 3 could make use of simple remembering of base knowledge. Thus, the baseline learning goal dimension would be adequate (Anderson *et al.*, 2001).

##	Description
L1	Learning goal dimension should be considered for co-created content
L2	Learning tasks (e.g., question types) should match the learning goal and dimension

Table 2. Requirements from related research

Followingly, when selecting learning tasks like what questions, quizzes or tests should be asked, the learning goals (i.e., what should be learned) and the goal dimensions (i.e., L1) should be considered (L2). These requirements translate into the CA supporting students during co-creation with instructions on what goal dimensions could be desirable and how example questions could look like (see figure 4).

Organizational requirements

These requirements are related to the boundaries set by our higher education setting and discussions we have had with university administration staff. First, the quality of the co-created content must be ensured and curated by a human tutor or teacher (O1). This step is required to avoid supplying students with co-created material that is false or unreliable. The second organizational requirement refers to existing laws in our environment i.e., EU and German law as well as university internal policies that demand strict protection of data and anonymity of students (O2). This second requirement is also partially reflected by student feedback of students who worry about "stupid" questions or answers being linked to them or their bad performance being publicly show cased. Thus, our artifact must be fully anonymized and follow the principal of data minimization.

##	Description
O1	Quality of learning content must be ensured and verified by qualified teachers/tutors
O2	Principle of data protection, anonymity (i.e., EU GPDR and German DSGVO law)

Table 3. Organizational requirements

Technical requirements

Additionally, to strictly organizational requirements, there are also technical requirements that are partially related organizational restraint. The first technical requirement (T1) is that the prototype should be integrated in the existing educational landscape and particularly the university LMS. While the former partial requirement is also supported by students who do not wish to have to deal with yet another platform, the latter is mainly given by our organization that is not flexible concerning its LMS in use. Concerning T2, our university and states ministry of education require the solution to be open source and future proof. These two requirements are also reflected in our own agenda as we wish to support open education and provide both practitioners and academics with access to our artifact and enable them to create and use their own conversational co-creation tool down the road.

##	Description
T1	Direct integration into existing LMS (side by side to learning videos)
T2	Fully open-source and compatible with university systems
T3	Future-proof, leading conversational technology

Table 4. Technical requirements

Similarly, T3 also stems from both given requirements as well as our own agenda. The goal of this project is to provide a future-proof and scalable technology. In order to meet this requirement we chose RASA as conversational technology (Bocklisch *et al.*, 2017). The RASA platform fulfills all critical capabilities for modern conversational agents and was recently included in the Gartner Magic Quadrant for Enterprise Conversational AI Platforms. (Revang *et al.*, 2022a, 2022b). Moreover, recent studies also confirm the performance of RASA that is in par with some class leading conversational technologies from global players like Google (Liu *et al.*, 2019).

Prototype implementation

General application and integration

The resulting early-stage prototype is then integrated in a customized experimental version of the existing learning management system[1] of our university (see figure 3). The prototype is composed of two main sections: a frame for viewing dedicated learning videos (left side) and a frame for the CA (right side). The video itself features all regular interactive elements that allow rewind, fast forward or pause and have no restriction for the learners implemented.

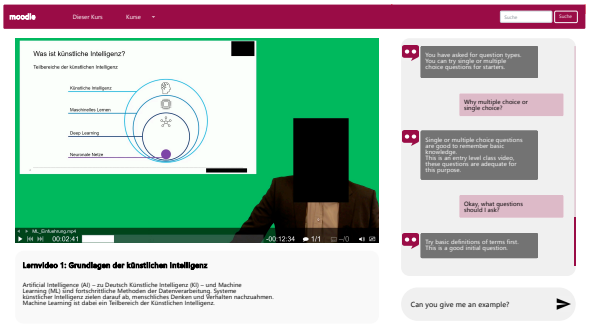

Figure 3. LMS integrated prototype

By implementing our artifact in this fashion, we address T1 as all components are integrated into the existing LMS and allow side by side usage. T2 is also satisfied as only fully open-source software is used (e.g., Moodle LMS and RASA conversational AI). The latter also addresses T3 and satisfies the requirement for a future proof and established technology in form of a CA based on the RASA platform. The intuitive and simple design should also satisfy U1 since all included elements should be known to users of any modern computer application user, especially younger ones like university students that are our target user group.

Conversational co-creation agent

The CA as seen on the right side of figure 2 also follows a simple and intuitive design (see figure 4). Regarding the functionality the early-stage prototype should satisfy all raised requirements as follows. The CA can provide useful information, answer simple questions and consult students with regard to question types and provide examples (U2). For instance, this translates into providing students with information on what type of question they could create and what learning goal dimension this would target (L1, L2). Figure 4 highlights this instance where the CA recommends the student to start by creating simple single or multiple-choice questions that target the lowest learning goal dimension. The CAs recommendation should be adequate for an entry level course where basic knowledge is focused. The students co-created learning content would then be saved anonymously to a data base for a human tutor to be reviewed (O1, O2). This early-stage prototype concept highlights how our raised requirements translate into a technological artifact.

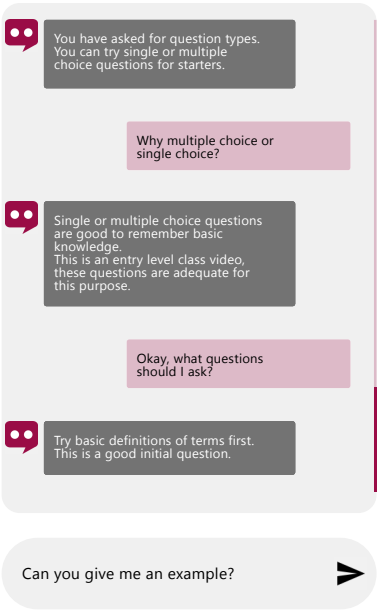

Figure 4. Co-creation CA

However, due to the nature of our CA being still in an early stage, not all requirements have been translated yet. We plan to iteratively develop our prototype to satisfy all raised requirements as well as potential new requirements that may emerge during ADR cycles.

NEXT STEPS AND EXPECTED CONTRIBUTION

Continuing our ADR journey, we will next test the already implemented requirements and the basic co-creation function with a small class of university students. We will also include tutors to evaluate the created learning material and put both test results in relation. Following this ADR cycle evaluation, we will continue down the path towards a first MVP with all requirements included.

A first follow-up implementation would be to target U3 and U4. Regarding U4 we plan to include the co-created and curated learning material into the MVP and allow the CA to also function as a learning mate. This way students can use the CA to co-create learning content for each other and answer each other's co-created learning content i.e., more or less directly learning with and from each other. This case would also fulfill our concept as proposed in figure 2. With regard to U3, we will also investigate the case of procrastination and task avoidance (Schouwenburg, 1995) since some students voiced issues with not being able to motivate themselves. This issue can become critical in a setting where students are encouraged towards self-regulated learning and co-creation of learning content

[1] The learning management system used in the context of this research is Moodle, see https://moodle.org/

(Senécal *et al.*, 1995), such as our setting. In this context, we may draw on motivating and engaging designs that can persuade students to engage in self-directed learning more responsibly and intently. This type of design that has persuasive power over users can be defined as persuasive system design and prove useful for further motivating and engaging students in potentially unfavorable learning and co-creation tasks (Fogg, 2009; Torning & Oinas-Kukkonen, 2009; Shevchuk *et al.*, 2019). Additionally, we will also evaluate the student experience and perception of using the CA to co-create and learn.

Moreover, while O1 is an organizational requirement set by our university, we wish to investigate alternatives to purely tutor curated co-created learning material. Therefore, we seek to investigate the following potentially viable alternative: first, we will employ machine learning to pre-process and cluster the content and second use pre-processed content in live learning settings and let students rate the content in order to further improve the selection of quality content creating with our approach. Especially the latter part would further emphasize on the whole concept of conversational co-creation since the interaction between learner and CA would be largely responsible for the new learning materials. In this circular relation students would co-create new content by interacting with the CA, then rate each other's content for the CA to select only the well-regarded ones and then allow students to learn from co-created and co-curated learning material.

Overall, we hope to contribute to practice by enabling university teachers to offer conversational co-creation to their students and consequently allow for a better experience in higher education. We also hope to advance theory in the context of conversational agents and co-creation (i.e., value creation in the context of higher education) as well as potential smaller contributions to niche contexts like formerly explained.

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