Co-Creation of Micro-Content Types.

Bernhard Göschlberger[1,2], Christoph Brandstetter[1], and Fabian Dopler[1],

[1] Research Studios Austria Forschungsgesellschaft mbH, Salzburg, Austria
[2] Institute of Telecooperation, Johannes Kepler University, Linz, Austria
{goeschlberger, cbrandstetter, dopler}@researchstudio.at

Abstract. In a knowledge society knowledge is dynamic, distributed and dependent on social context. The variety of professional communities of practice (CoP) and their individual knowledge needs are a challenge for community information systems for learning and knowledge exchange. Social Micro-Learning is an approach that allows the co-creation of new individualized knowledge artifact types for specific needs of a certain CoP. In this paper we propose a co-creation approach for Social Micro-Learning and evaluate it in workshops with four different CoPs in the professional domain. Our results confirm our assumptions about the diversity of knowledge needs and show that our co-creation process is highly appreciated.

Keywords: Social Micro-Learning, Co-Creation, Communities of Practice, Micro-Content Plug-In

1 Introduction

In a knowledge society we acknowledge that knowledge rather resides in humans than in books. Consequently, the challenges for an information system for learning are different. Knowledge is dynamic, distributed and dependent on social context. The theory of communities of practice (CoP) provides a theoretical model for the ubiquitous process of informal learning and teaching [18, 19]. We can find such communities in any context and in great variety. Consequently, their needs differ from community to community, and so do the requirements for community information systems for learning and knowledge exchange. Social Micro-Learning is an approach that allows the (co-)design of new individualized knowledge artifact types for specific needs of a certain CoP. In this paper we propose a co-creation approach for Social Micro-Learning and evaluate it in workshops with four different CoPs in the professional domain. Our evaluation goal is twofold: 1. evaluating our Social Micro-Learning information system, and 2. evaluating the co-creation method.

The remainder of the paper is structured as follows: First we briefly describe the background of our work and related research on co-creation, professional communities of practice, and Social Micro-Learning. We then describe our technical implementation in section 3. It consists of two parts: (1) our Social Micro-Learning system, and how it allows to develop and integrate new knowledge artifact types as plug-ins described in subsection 3.1, and (2) the Micro-Content Toolset as a developer tool for developing and testing new knowledge artifact types described in subsection 3.2 Subsequently we describe the methodological co-creation approach, and the design of our workshops in section 4, before presenting the results in section 5, and concluding in section 6.

2 Background and Related Work

Our work is based on three theoretical pillars: 1. co-creation, 2. Professional Communities of Practice, and 3. Social Micro-Learning. This section is structured accordingly, providing background and related work for these pillars.

2.1 Co-Creation

Generally speaking, co-creation is the act of creating together and involves shared creativity. It aims to increase the relevance of the created artifacts by involving stakeholders actively. For researchers and innovators co-creation is also a means to achieve higher adoption and impact of their work. There are several different methodological approaches that can be considered co-creation, such as co-design, co-production, participatory design, Design-based Research (DBR), and Living Labs [4, 7, 15, 16]. Sanders and Stappers used the term co-creation to refer to "any act of collective creativity, i.e. creativity that is shared by two or more people", and used the term co-design in a more narrow sense to refer to the "collective creativity as it is applied across the whole span of a design process" [16].

To design successful services it is important to take different perspectives and combine them productively. On the one hand this can be the needs of end users and customers and on the other hand the underlying technologies and processes.

In our work we use the co-creation approach, more precisely as a co-design method to develop micro-content types for a Social Micro-Learning platform. This is done through several workshops with different participants as end users, who bring in their different domain knowledge to develop solutions together with their own requirements in a creative environment.

Steen summarizes the important phases of such a design process. Following Dewey pragmatism, the exploration and definition of the problem is at the beginning of the process. This is formulated and can be further refined later in the interactive process. It is important that the participants can freely share their experiences with the others and empathize with them. Afterwards possible solution proposals are generated in this process and constantly questioned under special consideration of the requirements of the end users. These proposed solutions are then implemented as prototypes, tested and evaluated. This process can be repeated and carried out several times in order to iteratively further develop the proposals [17].

2.2 Professional Communities of Practice

Information and knowledge needs assemble individuals with a common interest, problem or responsibility to form a Community of Practice (CoP) [19]. These communities are not formally organized. Rather they are loosely bound by sharing a common practice—e.g. a craft or a profession—with the desire to learn from each other through knowledge sharing and knowledge building. Members negotiate and construct a common understanding, meaning and interpretation of the community's body of knowledge, and novices gradually learn the community's norms, values, terms and language to become an accepted member. CoPs emphasize a dynamic notion of knowledge that is constantly re-negotiated. Community learning processes are informal and embedded into practice [10], posing challenges for information system design. Learning occurs networked and practice is passed on among peers rather than passed down from a master to novice. For the individual the community

provides means to fulfill information needs, through knowledge residing within community actors and community artifacts.

For the purpose of this work we will focus on practices that are related to the professional life of their practitioners. Communities that are cultivating practices in the context of professional development are called professional communities of practice. The majority of professional CoPs cultivates niche practices, as the interests are diverse and follow a long tail distribution [1, 9, 14]. These communities of the long tail have specific needs that are typically unaccounted for by mass production. For the needs of these communities of the long tail we propose our co-creation approach for Social Micro-Learning.

2.3 Social Micro-Learning

Social Micro-Learning was designed as an approach to leverage the knowledge of communities, democratize content creation within organizations and foster meta-cognitive thinking, reflection and self-regulation. While typical Micro-Learning approaches are organized top-down, like a Learning Management System (LMS), Social Micro-Learning follows the paradigms of social software [5].

Micro-Learning is a paradigm that aims to enable learners to integrate learning activities into daily routines and perform them during idle times. Performance and activity tracking are important aspects of the concept. For one, because Micro-Learning is often combined with spaced-repetition as an adaptive instruction strategy and hence needs to measure and track mastery (c.f. Leitner-System [11]). Secondly, as Glahn points out in his Blog[1], performance is the basis for effective feedback. He subsequently defines Micro-Learning activities as minimal independent feedback loops. Follow his argument, we understand a unit of Micro-Content as an interactive digital learning resource that

(a) is self-contained, self-explanatory and can be presented without further context
(b) comprises a single learning activity that can be performed within seconds, and
(c) provides immediate performance feedback. Social Micro-Learning tries to support CoPs in creating and sharing knowledge artifacts by providing an information system that allows capturing knowledge as a Micro-Content unit. This also means that it needs to be easy to create Micro-Content at any time, and to recognize relevant artifacts right away.

Consequently we further understand Micro-Content to be

(a) designed responsively to fit a wide range of personal devices,
(b) instantly graspable through its visual representation, and
(c) easy to author.

3 Implementation

For the purpose to evaluate our concepts, we designed a Social Micro-Learning reference implementation [8]. Although multiple-choice questions can be used to address a number of different learning objectives, we argue that they are not sufficient to serve as the sole Micro-Content type for CoPs. In the following subsection we will

1 https://lo-f.at/glahn/2017/06/micro-learning-in-the-workplace-and-how-to-avoid-getting-fooled-by-micro-instructionists.html

describe how our reference implementation allows arbitrary Micro-Content types through the *Pluggable Micro-Content API*. Subsequently, we will describe the Micro-Content Toolset we designed to support development and testing of new Micro-Content types.

3.1 Social Micro-Learning

The Social Micro-Learning reference implementation displays Micro-Content as material design cards[2] with common controls in header and footer. The card body is dependent on the Micro-Content type. To provide maximum flexibility for Micro-Content type providers, we chose Google Caja[3] as a technological underpinning for our approach. Caja sanitizes JavaScript content using an object capability (OCAP) approach [13]. Thus it allows to embed, load and execute untrusted code securely. The application loading and framing the code is called host, the dynamically loaded code is called guest. In contrast to iframes, Caja allows the host application to define a JavaScript API that can be used by the guest (embedded third party code), and inherits CSS styles.

A Micro-Content type plug-in contains a Micro-Content editor plug-in and a Micro-Content viewer plug-in. The code of a plug-in needs to be hosted online, e.g. on github[4]. The reference implementation stores the URLs of the plug-ins and dynamically loads the code at runtime. The Micro-Content API provides defined methods to interact with the host application to store and retrieve instance data for both, the Content Editor plug-in and the Content Viewer plug-in.

Content Editor Plug-in. The main purpose of the Content Editor is to provide a form, which can be used to create an instance of the specific Micro-Content type. In other words it provides an interface for creating and editing.

A Content Editor plug-in has the following two methods that allow communication with its hosting environment:

getData() returns an object containing data for the editor (in case a user edits existing content) or undefined if there is no data yet (in case a user creates new content).

setDataGetter(func) takes a parameterless function as argument. The function should return a data object representing the current state of user input. The host environment will call this function to store the data for this instance.

Content Viewer Plug-in. The Content Viewer is responsible for displaying the actual Micro-Content. It displays the content for learning/consumption as created in the editor. That also implies that it has to provide elements to interact with (checkboxes, buttons, drag-and-drop elements, etc.). For every Micro-Content type, the host environment provides a *submit solution* button as a common UI element. Every Content Viewer has to support two modes which can be toggled by clicking the *submit solution* button. The first mode is interactive, where users can interact with the content and modify their response data. The second one shows the solution and evaluates the response data submitted by the user. These API design decisions are intended to nudge content providers to comply with the principles of Micro-Content as outlined in section 2.

2 https://material.io/components/cards
3 https://developers.google.com/caja
4 For example: https://github.com/MicroContent

The central methods for the communication provided to a Content Viewer plug-in by the host environment are the following:

getData() returns a data object representing the micro-content instance (as created with the editor). The data object essentially defines the values of an instance of the Micro Content type. E.g. a multiple choice card might have a title (string), a question (string) and an answer array. This method should be called before the view is initialized.

registerOnSubmitListener(func) takes a parameterless function that will be called when the user clicks on the *submit solution* button in the host environment. It should present the solution, feedback and insight to the user. The host that embeds the Micro Content will also provide a *submit* button and call the registered function.

sendXapiStatement(statement) takes an xAPI statement as a parameter. It is designed to log learning relevant user (inter)actions. The xAPI is a proposed standard to log, track and analyze learning activity data. The essence of a statement are actor, verb and object (Who did what with/to what?). A Micro-Content Viewer plug-in does not need to care about actor and object identification as the host environment will add actor, object.objectId and context.platform to the statement after it is passed to sendXapiStatement and before it is actually sent to an xAPI Endpoint. The host environment also takes care of where to send it to and how to authenticate the statement.

setXapiObjectGetter(getter) takes a parameterless function that is called by the host environment to obtain an xAPI object describing the Micro-Content unit. It is used to enable the host environment to issue xAPI statements for interactions with the content on the host environment level (e.g. a share statement).

3.2 Micro-Content Toolset

The Micro-Content Toolset (MC Toolset)[5] was developed to support communities in the development of their own Micro-Content plug-ins. It is a simple Java application consisting of a file server and a development host for Micro-Content Viewer and Editor plug-ins. While the file server serves the plug-in codes locally, the development host loads and displays them dynamically. As shown in figure 1, the MC Toolset provides a simple UI containing a view for the editor, viewer and the JSON data representing an instance of the content type. For developing, the editor form can be filled with data, that is then passed to the data view via the data-getter set in the Content Editor plug-ins *setDataGetter(func)* function. The data view then displays the JSON representation of the data in the TextArea. The Content Viewer plug-in can then finally load the JSON data using the *getData()* function, and it can be used for further development on the viewer.

To test the MC Toolset, we developed and published five different example types under the permissive MIT License: Multiple-Choice, Order/Sequencing, Matching, Fill-In and Binary-Number[6].

5 https://github.com/MicroContent/McToolset

6 Specialized content type for learning binary to decimal conversion

4 Workshops

To evaluate our approach we chose a wide range of professional CoPs and held co-creation workshops with our tools. In order to support co-design activities there are a variety of methods and processes to inspire the participants and to create common ideas and concepts. These methods and processes can be productively combined using the dialogue-labs method [12]. Dialogue-labs and its three important elements—process, space and materials—create a structured framework to generate creative ideas through a variety of co-design activities. Through this process, ideas and solutions for the design problem can be generated within a 2-hour workshop, step-by-step through varied discussion settings. The common space of the workshop was designed to inspire and encourage the participants to move around in the space and to promote the common exchange. Furthermore, the participants were provided with different materials to facilitate a common design language and different approaches to problem solving.

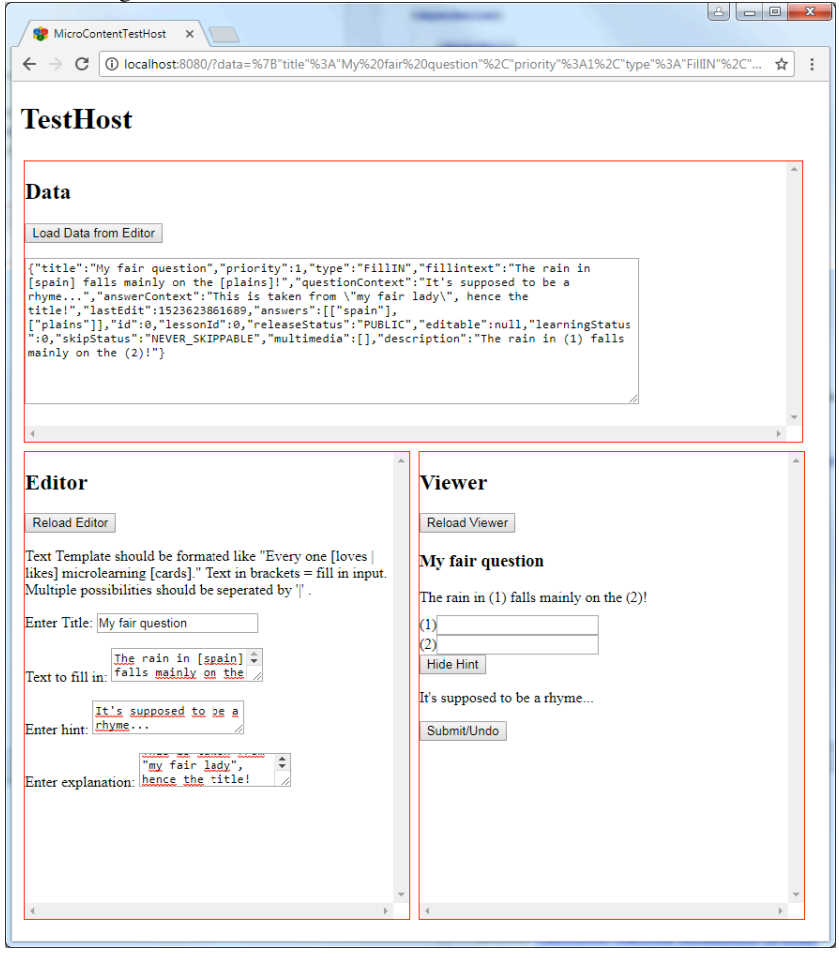

Fig. 1. The UI of the MC Toolset providing a view for the editor viewer and the exchanged data.

Our co-creation process shown in Fig. 2 consisted of three different phases in order to promote the joint creation and production of Micro-Content types and to be able to evaluate these afterwards. In phase 1, we worked with four different professional CoPs, from different areas of knowledge, knowledge domains and Micro-Content requirements, to solve the problems of their environment. In this phase, four different workshops were held at different times and places. In phase 2, the results of the workshops were then processed and implemented into the existing system using the MC Toolset. This was carried out by us in order to enable a quick and target-oriented implementation. In the last phase, the Micro-Content plug-ins were implemented and released for evaluation. The participants were asked to use the system to create their own Micro-Content and to evaluate the results with the help of a questionnaire.

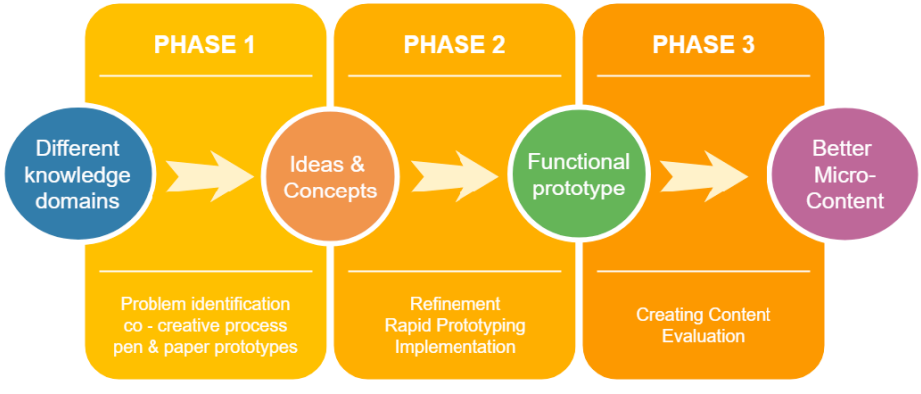

Fig. 2. Our co-creation process

We only included participants in this study that took part in both workshop and evaluation. Between 3 and 6 participants of each CoP took part in the respective workshops and the subsequent evaluation in the last phase. In total 15 persons of four different CoPs participated in our study.

4.1 Workshop Structure

In order to enable the joint creative work on problem solving the workshop itself was set up with the help of the dialog-labs method and structured as follows:

1. Introduction (20 minutes):
In order to create a creative and conducive relaxed working atmosphere, the participants were welcomed and introduced to each other. In addition, the goals and background of the workshop were explained and summarized to create a common reference to the material. Firstly, this created the framework of content that this workshop was about and secondly, it enabled the participants to create empathy with the end users. In addition, participants were asked to read and sign a consent form allowing us to subsequently use and process the data and results of the workshop for scientific purposes.

2. Problem Definition (15 minutes):
Participants were asked to identify their current learning topics and learning problems they are facing within their knowledge domain. This leads to the fact that many abstract subject areas can be named, which have to be concretized in the course of this phase and then a specific problem can be formulated. These problems are the starting point for further steps in this workshop and serve to create a common understanding of the initial situation. The formulation of the problem is particularly important since it is the basis for the decision on whether and how the proposed problem is considered in the further process.

3. Co-Design Rounds in Pairs (2 x 15 minutes = 30 minutes):
After the problems were identified, the participants were allowed to form groups of two for the first round and select a specific problem from the list on which they want to work. The moderator ensured that conflicts of interest could be resolved and that the time schedule could be adhered to. We decided to work on the task in teams of two people each, because it enables the participants to concentrate on the task, detached from group dynamic influences as found in larger groups. In pairs, it is easier for the participants to communicate on an equal footing and at eye level. It was important to have an expert on the knowledge domain in each pair on the one hand and an end user on the other. After 15 minutes, the pairs were reformed and another problem from the list was worked on. Some groups already started to build first prototypes using different materials.

4. Idea Sharing (15 minutes):
The participants were again gathered together at one table to exchange and discuss the ideas developed in the previous step. Thus the individual ideas could be enriched by valuable inputs and further developed with fresh ideas. As the ideas were worked on in alternating pairs, the presentation and discussion among the participants alternated constantly, leading to a lively exchange of new inputs which served as a starting point for further development of the prototypes in the next step of the workshop.

5. Group Co-Design (15 minutes):
The participants worked and evaluated the ideas and concepts as a team. This discussion was led by a moderator who could flexibly adapt the strategy of this step to switch between generating and evaluating the ideas. The participants were then able to use the existing materials (e.g. paper, pens, adhesive tape) to further refine the first prototypes or create new ones. Here it made sense for the participants to create the space to move creatively and to be able to unfold freely in the space. The prototypes fulfilled the functional requirement to serve as a basis for implementation within the existing system and enabled developers to further enhance it.

6. Closing Discussion (15 minutes):
To conclude this discussion, each individual prototype is examined for unresolved and open questions. These formulations and results in this step serve to define the limits of the prototype and to provide possible points of contact in further follow-up workshops through which these ideas can be further developed.

7. Debriefing and Workshop Evaluation (15 minutes):
In the last step of the workshop the results were summarized and evaluated by the participants. Each individual participant completed a questionnaire on each individual idea. In these questions, the participants were asked to give feedback on the advantages and disadvantages of each idea and then to evaluate the idea on a numerical scale. This feedback also served as a basis for deciding which ideas to

implement for the next phase of the process. Finally, an evaluation sheet for the workshop itself was distributed and filled in by the participants to improve possible future workshops.

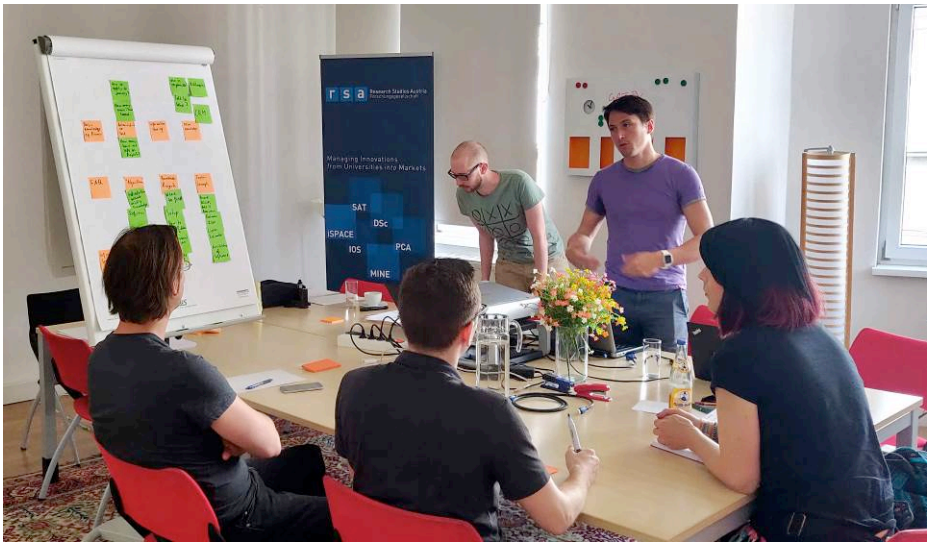

Fig. 3. Example Problem definition at a specific Workshop

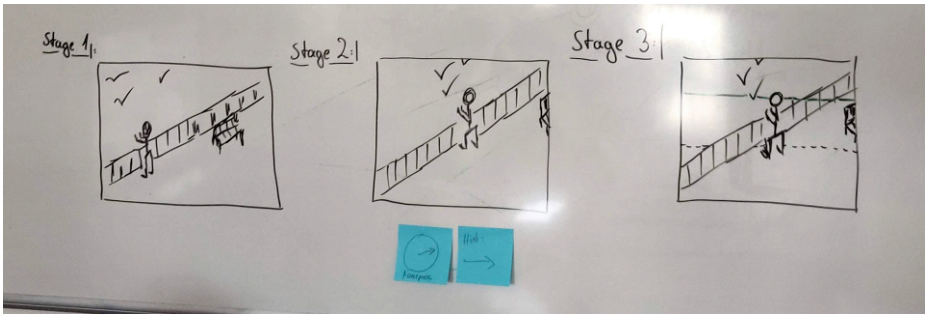

Fig. 4. Example of early stage idea

4.2 Participating Professional CoPs

A total of four co-design workshops were held with four different professional CoPs in different knowledge domains, professional contexts, and application areas.

Research Organization. Research is a typical case for knowledge intensive work. Therefore, we held a workshop with colleagues from other departments, namely the teams of the Research Studios SAT, DSc and PCA of the RSA FG. In this field,

researchers often have problems with documenting and explaining their findings and research within the team and with other stakeholders. In particular, algorithms and data structures are a particular problem where it is necessary to develop alternatives to already existing types of Micro-Content. Three persons of the aforementioned teams participated. One of them is data scientist, one a usability researcher and one a pervasive computing researcher.

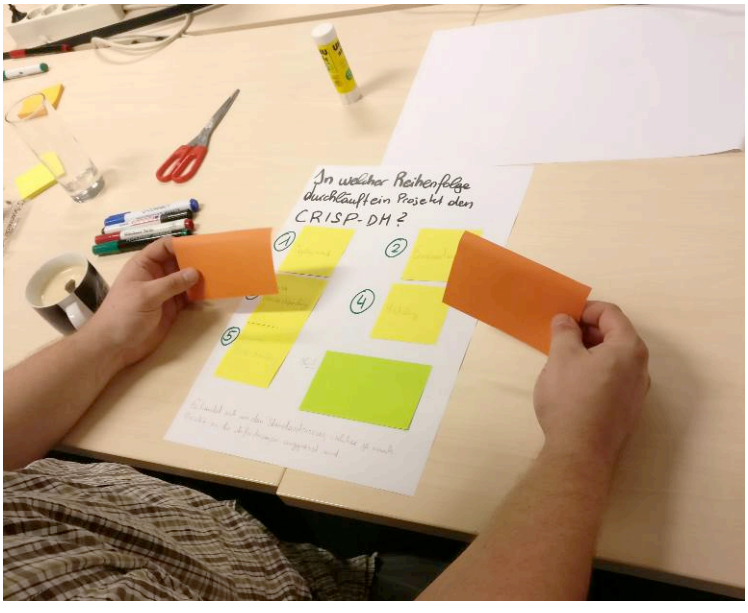

Fig. 5. Example of Paper Prototype

Creative Industry. Creative work is another knowledge intensive area, that is however very different from other industries. Therefore we held a workshop with the team of a creative agency focused on video production and story telling (Generative3). Although these are technical or non-technical knowledge units that have to be exchanged in the daily field of application, in this domain of knowledge the participants already have experience with creative problem-solving processes. Thus, the requirements for new types of Micro-Content are especially connected with the challenge to specify implicit knowledge to concepts (e.g. storytelling) and to transform it into sharable knowledge units. Three managing partners of the agency participated. One of them has a strong videography background, one is a music producer and the last one is a web designer.

Transdisciplinary Competence Team. Knowledge sharing is also pivotal in transdisciplinary teams, consisting of experts of different fields. As an example for such a use case we held a workshop with the Predictive Analytics Competence Center (PACC) of the Austrian Ministry of Finance. The team at the PACC is formed by legal tax experts, providing domain knowledge, and data scientists implementing predictive models. Three tax experts and three data scientists took part in our workshop and subsequent evaluation.

Clinical Psychology. The fourth workshop was held with a team of clinical psychologist at a therapy center. In clinical psychology the amount of tacit knowledge is inherently high. Psychologists are used to exhaustive documentation processes, but lack tools to transfer knowledge on treatment procedures, approaches and methods in a sustainable way. While patient treatment is documented thoroughly personal experiences with treatment approaches and methods are not. The current state of the art methods such as supervision rely on co-location and hamper exchange across institutions or even across wards. Three clinical psychologists took part in our workshop and the subsequent evaluation.

4.3 Refinement, Implementation and Evaluation of Workshop Outputs

After these workshops, the prototypes developed in the co-creation process were implemented as Micro-Content plug-ins using the MC Toolset. Sample Micro-Content units using the newly created plug-ins were authored for the result evaluation. Figure 6 shows example Micro-Content for each of the four groups.

Table 1. Comparison of the four workshops with respect to the knowledge problem, visual representation, user interaction, and performance feedback.

Workshop	Knowledge Problem	Visual Representation	User Interaction	Performance Feedback
Research Organization	manipulate a dataset, such that a certain level of anonymity is guaranteed	Data Table	edit cell data by typing textual input	show anonymized rows in green identifiable rows in red and display the level of ambiguity per row
Creative Industry	design an appropriate filter for a given problem in audio editing	Gain-Magnitude Frequency Diagram	adjust magnitudes by dragging defined points on the curve along y-axis (x-axis position fixed)	show correctly placed points in green incorrect ones in red and on the right position
Trans-disciplinary Competence Team	remember and understand organizational structures and hierarchies	Organizational Chart	place items correctly on the blank organizational chart using drag&drop	show correctly placed items in green incorrect ones in red
Clinical Psychology	choose a suitable set of tests, treatments and methods for a given vignette	Response Item Pool	move items into the selection pool using drag&drop	show correctly placed items in green incorrect ones in red

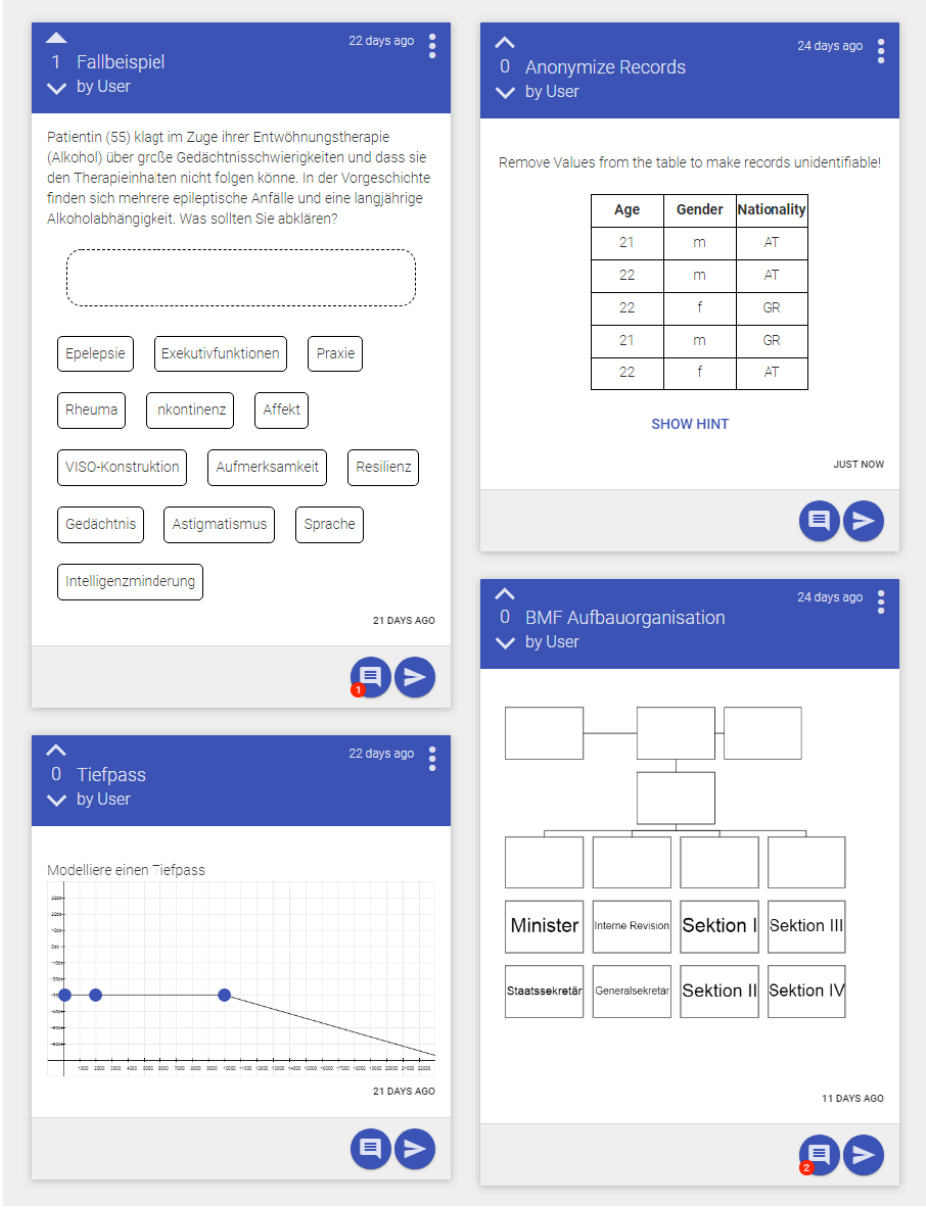

Fig. 6. Resulting artifacts of the Micro-Content type co-creation Process (from left to right, top to bottom): Item Pool (Clinical Psychology), Data Table (Research Organization), Gain-Magnitude Frequency Diagram (Creative Industry), and Organizational Chart

5. Evaluation

Our evaluation focused on two aspects: process and outcome. To better understand the outcome of the different phases, we distinguish between the co-created paper prototypes and the actual digital implementation of the Micro-Content plug-in.

5.1 Workshop Evaluation

At the end of the workshop, the participants were asked to evaluate the workshop. We used a qualitative questionnaire to collect the opinions of the individual participants. This written questionnaire consisted of open questions like "What did you like about the workshop?". We subsequently anonymized and summarized the collected data. The overall results were very positive. Participants felt that the co-creation process for Micro-Content types was a good methodology and approach to address specific knowledge problems. Most of the participants had no prior experience with a co-design process, but noted that from their point of view it is a suitable tool to accomplish the task. The participants particularly liked the timed structure of the process, where time frames for the individual steps were given.

Group size was also perceived as suitable by participants and researchers. The groups have to be large enough to enable and promote mutual exchange, but also small enough to ensure equal engagement and mutual exchange of all participants without violating the time constraints.

Participants noted that it was an advantage that the moderator summarized intermediate results of the individual steps several times and visualized them on the available presentation media. They stated that it helped to maintain a structure in the rather open process and to follow the process. At the same time, however, it was also positively noted that the moderator did not intervene in the free discussion and thus made open and free discussion possible.

In the course of the co-creation process it was a big challenge to create a relaxed atmosphere and to find a common design language for the participants. It turned out that the moderator was very helpful in situations where the participants needed impulses for problem solving. Facilitating the search for a common design language among the participants proved to be an important building block of the process.

5.2 Evaluation of Co-Created Artifacts

At the end of the workshop, participants were also asked to provide qualitative feedback on the chosen solutions and to evaluate them using three criteria:

Learnability. This question aims to evaluate how well the designed Micro-Content type is suited to learn and acquire new knowledge. Good learnability is characterised by a simple and targeted representation of the learning problem.

Shareability. In the context of Social Micro-Learning, knowledge artifacts are shared with, altered and rearranged by other learners inside and outside the technical system.

The question on sharability asks how well the Micro-Content type is suited to share knowledge in the group.

Integration. Many of the participants use already existing solutions to acquire and exchange knowledge. This question aims to evaluate how well the ideas developed in the workshop can be integrated into the existing personal learning environment.

We developed a questionnaire items for the three criteria using Likert scales. The results were then standardized to a scale range of 0 - 100. Table 2 shows the results of the qualitative feedback and the three criteria. Especially the representations of "Data-Table", "Frequency Diagram" and "Organizational Chart" achieved high results in learnability and shareability. The type "Response Item Pool" received a lower score compared to the others. A participant noted that the Micro-Content type is suitable for a general overview of a topic, but cannot represent deeper knowledge on procedures and practical guidelines.

For integration, with the exception of the "Frequency Diagram" type, we found rather low scores. As we found no explanation in the open questions, we can currently only speculate about the reasons. On the one hand, participants were instructed to design their solution without thinking about their technical and infrastructural framework. Thus, they were not restricted to design for their technical system environment in advance to avoid any inhibition of the creative work. On the other hand, participants either use corporate learning environments, which are not designed for integration of new types of learning, or do not use dedicated online learning tools at all. Since questions about the term personal learning environment did come up several times in the evaluation, we could tell that participants typically did not account for personal and informal learning, but institutionalized formal learning only.

5.3 Evaluation of Micro-Content Type Plug-ins

After the implementation of the new Micro-Content type plug-ins, the participants were asked to test and evaluate the new card types in a virtual test environment set up especially for this purpose. For the evaluation, participants were given the opportunity to (a) try out existing Micro-Content, (b) create new Micro-Content with the newly created Micro-Content type plug-ins. The workshop participants were then asked to complete a questionnaire consisting of two open questions, a set of standardized questions regarding system usability, and two specific questions regarding the implemented Micro-Content types in comparison to traditional multiple-choice content. To measure usability, we used the system usability scale (SUS) [6]. The SUS is a simple and technology-independent standardized questionnaire consisting of 10 items, assessing effectiveness, efficiency and satisfaction.

Bangor, Kortum and Miller [2] associated the SUS scores with a 7-point adjective scale. The scale contains adjectives including "Good," "OK," and "Poor"—words users loosely associate with the usability of a product. Another type of interpretation they introduce is to think in terms of what's "acceptable" or "not acceptable". Acceptable corresponds roughly with scores above 70 and unacceptable to below 50. They designated the range between 50 and 70 is described as "marginally acceptable" [3].

Table 2. Feedback on Micro-Content type paper prototypes

Visual Representation	Feedback	Learnability	Shareability	Integration
Data Table	- usefull illustration of common problem - direct Feedback when solution is displayed - color coding very practical	96	63	52
Gain-Magnitude Frequency Diagram	- interactive visualization - textually otherwise very difficult to represent - different solutions possible	83	72	89
Organizational Chart	- well suited for learning hierarchies and organizations in a playful way - easy to adjust structure - can be supplemented with additional information - limited application scenarios	83	69	44
Response Item Pool	- it is suitable for a more general overview of the questions and provides material for the following in-depth questions - several decisions can be made - the feedback is given according to importance	63	63	52

In our situation, the achieved SUS scores are quite meaningful and confirm the good implementation of the workshop results in our system. Only the type ”Response Item Pool” differs slightly from the average. In contrast to other groups, the clinical psychologists used smartphones for the evaluation, which might have partially impacted their SUS scores. Bangor et al. also report slightly lower average SUS scores for mobile phone interfaces (65.9 for mobile, 68.2 for web) [3]. Table 3 shows the normalized numerical results and the corresponding textual description.

The qualitative answers to the advantages and disadvantages of the implemented solutions essentially correspond to the feedback we received at the end of the respective workshops before the implementation in the system took place. Although the implementations were as close as possible to the original idea, some participants also noticed subtle differences and reported them in their feedback.

Regarding the Micro-Content types in comparison to traditional multiple-choice questions we asked the workshop participants (a) whether the respective Micro-Content type is suitable for learning the specific learning content more effectively, and (b) whether the respective learning card is suitable for learning the specific learning content more efficiently.

Table 3. SUS Score of new Micro-Content type plug-in implementations

Visual Representation	SUS Score	Adjective	Acceptability
Data Table	66.25	Good	marginally acceptable
Gain-Magnitude Frequency Diagram	68.75	Good	marginally acceptable
Organizational Chart	65.83	Good	marginally acceptable
Response Item Pool	55	OK	marginally acceptable

6. Conclusion

In this paper we proposed a co-creation approach to create new Micro-Content types for Social Micro-Learning. We use co-creation workshops to create paper prototypes that are subsequently transformed into a digital Micro-Content plug-in. Our evaluation with four different CoPs in the professional domain, shows that we find a great variety of needs that is not addressed by commercial off-the-shelf solutions. Participants evaluated the co-creation process very well, suggesting that the method is well suited for customized Micro-Content for professional CoPs of the long tail. Especially the interdisciplinary cooperation among each other had a significant positive influence on the result.

While the small scale of our evaluation is a limitation, we believe that the diversity of the addressed CoPs strengthens the study's validity and significance.

Yet we plan further evaluations with other CoPs in the future to back our findings. For future workshops we want to provide a wider choice of materials for prototyping and more background information about the project and Social Micro-Learning.

The workshop products were also evaluated positively, with the exception that participants felt that they could not integrate them well into their personal learning environment. We want to further investigate this specific observation in the future. Consequently we want to emphasize the problem of integration, such that the participants can also take this into account in their creative process.

The results regarding system usability were acceptable. However, it is difficult to estimate the impact of our co-creation approach on usability yet. For future evaluations, we will try to setup experiments were participants can use the Social Micro-Learning reference implementation over several weeks before the co-creation workshop and ask participants more specifically about the impact of the new content types on system usability.

Here the co-creation process provides us with a better approach to better understand the individual needs of each user and to participate in the development process.

Finally, we conclude that co-creation is a suitable approach to address the issue of the diversity of needs of professional communities of practice. In comparison to other approaches, where requirements are obtained separately from development through verbal interviews with the stakeholders, co-creation has three advantages:

1. consistent understanding of requirements among the CoP by developing a common design language,

2. consistent understanding of Social Micro-Learning through the moderated setting, and
3. high engagement and involvement of CoP members through integrated, participatory process.

We also believe that our Micro-Content co-creation approach is economically feasible, since both, the prototyping and the implementation effort is rather low. In practice, we recommend multiple iterations to refine solutions and develop multiple Micro-Content plug-ins for a single CoP, as we expect even better results as the group familiarizes with the process.

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