Towards scaffolding collaborative articulation and alignment of mental models

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Abstract

Articulation and alignment of mental models has been recognized as an important issue in knowledge management over the last years. In the context of collaborative work processes, much research has been conducted in the field of how to facilitate such articulation and alignment activities to produce knowledge artifacts that appropriately represent organizational reality. However, the aspect of sustainably developing articulation and alignment capabilities for operative personnel has hardly been addressed so far. The article uses the educational concept of scaffolding to approach this problem. We review existing related work with a scaffolding lens and identify approaches that can be used to pursue scaffolding. We then report on a multiple case study we have conducted to identify potential for implementing different types of scaffolding in collaborative conceptual modeling activities for articulation and alignment. The results are used to show the potential value of scaffolding to trigger and support individual and collective learning processes in organizational problem solving processes as addressed by knowledge management research. The findings presented in the article allow to derive questions that should guide future research in this area.

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1. Introduction

Articulation and alignment of knowledge that guides collaboration in work processes has been addressed in nearly every knowledge management approach proposed over the last decades. Nonaka & Takeuchi[1] describe the phenomenon of articulation in the externalization and combination phases of their SECI cycle. Probst et al.[2] cover articulation in their elaboration on knowledge acquisition, creation and transfer. Firestone and McElroy[3] refer to activities related to articulation of knowledge in their Knowledge Lifecycle the phases of problem claim formulation and knowledge claim formulation. Senge[4] in his seminal work on the five disciplines of knowledge management proposes to explicitly describe mental models that guide individual and collective action and use them in team learning. Summarizing, "articulation" refers to the process of encoding individual mental models[5] about a particular work process in a tangible form ("artifacts") that enables reflection[6,7] and sharing[8]. Processes of "alignment" consequently build upon these artifacts, and are used in collaborative settings to alter and extend the individuals' mental models. This enables them to operatively work together[9,10] and modify the artifacts accordingly to represent the aligned understanding.

The representation of mental models in externalized artifacts is often approached via creating diagrammatical conceptual models. Concept maps[11] have been shown to appropriately serve the purpose of articulation and alignment of knowledge guiding individual and collective action[12,13]. Senge[4] proposes to use system dynamics models[14] to describe the behavior of (work) systems. Neither of these approaches, however, is explicitly tailored to describe knowledge about work and its collaborative dimension. Language semantics in concept mapping is deliberately left flexible, whereas in system dynamics, the semantics of model links and nodes focus on describing dynamic relationships between system elements. In contrast, conceptual languages tailored to represent collaborative work processes, such as BPMN[15], provide elaborated semantic constructs to describe work settings, but do hardly consider the aspect of articulation and alignment in their design, making them only partially suitable for this purpose[16]. This aspect consequently needs to be addressed when aiming to use conceptual modeling to represent mental models about tasks and interactions in a collaborative work process.

Furthermore, the capability to use conceptual modelling for the purpose of articulation and alignment must not be assumed to be present for all participants[17][18]. Inexperienced participants require more support and guidance than more experienced ones. However, the latter might be hampered by an enforcement of modelling structures of procedures, leading to less articulation and alignment activities[19]. These findings are in line with research conducted in educational science under the label of „scaffolding"[20], which is characterized by a fading of support measures and transfer of responsibility with rising skills of learners. The results from research on scaffolding, however, have not yet been transferred to the area of articulation and alignment of mental models.

The present paper is a first step toward addressing this gap. It sets out to explore, whether work-oriented conceptual modelling languages can facilitate the process of articulation and alignment of knowledge about work processes and tries to identify, how concepts stemming from scaffolding research could be used to provide appropriate support to the participants in such a process. The theory of scaffolding has developed from a pedagogical background to aid the development of problem solving skills via adaptive support measures. Knowledge management as a discipline could benefit from this approach as it provides operationalized guidance on how to trigger and support individual and collective learning processes[4] based on real-world organizational challenges[3]. The findings derived from this study indicate the potential of considering the principles of scaffolding in the design of knowledge management instruments and interventions and thus allow to establish a foundation for future research in this field.

The remainder of the paper is structured as follows: Section 2 summarizes the kernel theories underlying the present work to set up our research framework. Section 3 gives an account on related work available the area of collaborative articulation and alignment via conceptual modelling, reviewing it with respect to scaffolding principles that already might have been explored. Section 4 describes a multiple case study we have conducted in order to explore influence factors and requirements on conceptual modelling techniques in order to create scaffolds for facilitating articulation and alignment. We close with a discussion of our results and draw conclusions on necessary further directions of research.

2. Kernel Theories

In the following, we briefly describe the theories underlying the present research. Research on mental model theory and scaffolding of learning processes constitute our research framework. It enables to review the available related work in section 3 and understand the design decisions made for the modelling approach used in the cases study described in section 4.

2.1. Mental Models

People's activities in a work process, their decisions and reactions to contingencies are driven by their perception of organizational reality[21]. How people perceive their work context in an organization and how they derive their reactions on these perceptions is examined in cognitive sciences in the field of mental model theory[22]. Mental model theory also has been used in knowledge management to explain operative triggers of organizational change processes[3]. In the present article, we use mental model theory to describe individual and collective learning processes, i.e., the adaptation of mental models to accommodate perceived changes in the organizational environment[23].

Mental model change requires to recognize the lack of adequacy of one's mental model and the opportunity and willingness to reflect on and adapt the mental model. In collaborative work settings, mental model change might not be restricted to a single person but might require to involve all actors in the work process in the reflection and change process. The willingness of changing a mental model that has been recognized to be inadequate by an individual can be assumed[21] (not imposing any assumptions about the quality of the change). Still, having the opportunity to adapt a mental model by gathering the required input and being able to retrieve it in an adequate form, can be an issue (ibid.). In collaborative settings, the willingness of other actors to change their mental models must not be assumed. If they do not perceive the environmental setting to be „problematic"[24], inquiries for change are usually met with resistance[25].

Those challenges of can be met with explicit activities dedicated to articulation, reflection and alignment of individual mental models [26]. Such activities need to be facilitated by providing artifacts that can serve as focal points of discussion and act as anchors for developing a mutual understanding about the subject at hand [27]. Conceptual models have been widely recognized as an appropriate mean to serve as external artifacts representing mental models [5,11,28].

In order to effectively use these artifacts, the involved actors need to be methodologically capable to participate in such articulation and alignment activities[17]. The fundamental requirement to be met here is that they are capable in understanding and actively using the representation forms used to develop the artifacts[8]. This challenge needs to be explicitly addressed and should be embedded in the articulation and alignment activities[29] [30].

2.2. Scaffolding

Scaffolding is a concept introduced in the field of educational tutoring by Wood et al. in 1976[31]. It originally refers to having an experienced person help an unexperienced learner to acquire knowledge about a particular topic. Scaffolding is a metaphor adopted from construction industry and refers to a temporary means of support that is present until the supported entity (here: a learner) can accomplish a given task itself[20].

Scaffolding can take different forms. Jumaat & Tasir[32] distinguish conceptual scaffolds, procedural scaffolds, metacognitive scaffolds and strategic scaffolds based on a meta-study of scaffolding research. *Conceptual scaffolds* help learns to decide what to consider to be worth learning. In particular, they can help to prioritize fundamental concepts. *Procedural scaffolds* assist students in using available tools and methods and point them at potentially useful resources. *Strategic scaffolds* suggest alternative ways to tackle problems in learning. Finally, *metacognitive scaffolds* guide students on how to approach a learning problem and what to think about when elaborating on a problem. Bulu & Pederson[33] identify orthogonal categories by distinguishing the sources of scaffolding. *Scaffolds provided by teachers* are considered the original form of scaffolding. *Scaffolds provided in interactions among learning peers* refer to the phenomenon that scaffolding can arise from the collective knowledge of a learning group. Scaffolds can also be provided as *textual or graphical representations*, similar to a manual. *Technology-driven scaffolding* finally uses (information) technology to provide scaffolds. This includes software programs that try to observe learners' behaviors and intervene appropriately in the learning process.

Independently of which form of scaffolding is pursued, it is always characterized via the presence of three principles that have been identified by van de Pol et al.[20]: The first common principle is *contingency*, which is often referred to as responsiveness, or tailored, adjusted, differentiated, or calibrated support. Scaffolds need to be adapted dynamically to the students' current level of performance. The second principle is *fading*, which refers to the gradual withdrawal of the scaffolding. As learners develop their skills, support becomes less necessary and is decreased over time. This is closely connected to the third principle *transfer of responsibility*. Via fading, responsibility for the performance of a task is gradually transferred to the learner. The responsibility for learning is transferred when a student takes increasing control about the learning process.

On an operative level, scaffolding is implemented via different means. Van de Pol et al.[20] list a (non-exhaustive) set of measures such as giving feedback, providing hints, instructing, explaining, modelling (i.e. demonstrating the skill to be acquired) and questioning. They differ in their depth of intervention and the reduction of freedom in students' learning processes. How to appropriately select and implement scaffolding as interventions in the learning process is disputed (ibid.). The described categories and means thus should be considered a framework for observing and designing learning settings, rather than attributing them any normative value.

3. Related Work

The topic of supporting knowledge articulation in collaborative setting to reach a common understanding about a particular topic has gained rising attention in research over the last years. In the following, we review the state-of-the-art and analyze its contributions in the light of the kernel theories described above.

Dean et al.[34] describe an approach to facilitate involvement of actors in collaborative modelling. Their objective is to involve end-users in conceptual modelling activities for information system design as early and continuously as possible to achieve a more comprehensive model representation in a shorter period of time. They propose to use a groupware tool to facilitate group modelling processes and examine different modelling strategies that were implemented using the tool in combination with different facilitation strategies. In particular, they performed the initial modelling steps in a chauffeured manner with all participants, before letting them create sub-models autonomously in small groups. Their findings indicate that this strategy led to inconsistencies and consequently to frustration during consolidation. They argue for creating a shared conceptual context, in which small groups can embed their models to avoid inconsistencies.

Santoro et al.[35] propose to use group storytelling for business process elicitation. They claim that group storytelling enables to reach consensus about the respective topic and allows peer-checking of the described processes. In a second step, they develop a business process model from the stories. The whole process is facilitated by a person, who mediates the story telling process, links facts between the stories and supports the abstraction process towards a common model. This abstraction process comprises merging the individual stories and reaching consensus about the main process elements. This process is supported by t a computer tool by prompting for input about different aspects of the process (e.g., who is involved?, what happens?, etc.). The actual model is created by process analysts, who translate the story abstractions to graphical models.

Herrmann & Loser[36] follow a similar approach in terms of the collaboration setting and the approach to prompt for input by process participants. They do not work with stories but use the SeeMe modelling language[37] to capture knowledge about work processes directly in graphical representations. Similarly to Dean et al.[34], they propose to split the modelling task into smaller groups. As their methodology relies on prompting through a facilitator, they explore the opportunity to leave this task to a software application that can support the small groups in absence of a human facilitator. They refer to the activities of the human or software facilitator as scaffolding but do not elaborate further on the implications of using this concept.

Franco & Rouwette[19] discuss, how decisions development in the course of facilitated collaborative modelling workshops can be effectively examined. Their objective is to identify patterns of how facilitation inputs influence the process of decision making. They consider models as „transitional objects" that enable group members to construct a shared reality. Their summary of existing work in the field of „facilitated modelling" indicates that enforcement of modelling procedures results in simpler decision paths, leading to different, less comprehensive outcomes. Still, they found evidence that a prescribed, normative high-level phase sequence during modelling is likely to lead to more successful outcomes.

Hoppenbrouwers & Rouwette[38] build upon these results and propose to frame (i.e., structure) collaborative modelling procedures in a multi-phase approach as proposed above. A facilitator is responsible to guide the process. The modelling process is conceived as a „game", i.e., a goal-oriented and rule-based interactive system. Consequently, the goals and rules are made transparent to participants and are encoded in a supportive software tool in order to provide guidance. In addition, interaction among participants and the facilitator is structured with explicit semantic categories for statements issues by either actor (e.g., „ask", „agree", „accept" for participants, „instruction", „directive", „request ideas" for the facilitator). In the evaluation of their approach, they could identify, that the explicit semantic structuring of the conversation was found helpful by inexperienced facilitators, whereas more experienced people might not find them useful.

Front et al.[39] propose a participative end-user method for multi-perspective business process elicitation and improvement, which is supported by a tool supporting modelling and validation of models. They structure the modelling process along different perspectives, which are used to constitute different modelling phases that can be combined flexibly (e.g., start with modelling the organizational perspective of a process, continue with construction an informational model, build an interactional model by IU sketching using the prior specified models and validate the whole set of models by simulated enactment). They mention the availability of a conductor/modeler supporting these processes, but do not elaborate on this role. From their findings, it, however, seems that the sequence of phases appears to be critical for modelling success, but is dependent on the intended outcome. Proposing an appropriate sequence of modelling phases thus would be a task for the conductor.

Tavella & Franco[40] describe the dynamics of group knowledge production in facilitated modelling workshops. Their objective is to study the mechanisms „through which facilitated modelling interactions evolve, moment-by-moment, among those involved, and how they contribute to the workshop outputs" (ibid.). They analyze modelling workshops based different types of statements participants can utter in a collaborative modelling workshop (e.g., inviting, proposing, affirming, challenging, …). In this way, they identify different interaction patterns (generative, collaborative, assertive) that differ in the types of statements the participants and the facilitator use to shape their interaction. Still, they show that these patterns must not be considered to be normative, as their success depends on the interaction context in which it is used.

Finally, Hjalmarsson et al.[18] have examined different facilitation styles in business process modelling. They identify four behavioral styles that differ in how a facilitator guides a modelling process. These styles are backed with dichotomous behavioral anchors, which are used to characterize each style (e.g., listening vs. taking, flexible vs. static, lets group model vs. models himself, involves participants vs. disconnects participants, domain expert vs. agnostic). Those anchors are put in the context of situational factors such as the purpose of process modelling (to-be vs. as-is modelling) and the process modelling maturity (low vs. high), which refers to the experiences of the participants in the area of process modelling. In their empirical study, they could confirm that a more authoritative modelling style is preferred in settings with lower process modelling maturity (i.e. less experienced participants), whereas higher process participant maturity requires a less intervening facilitation style, in which support is only provided when requested by the participants. In a follow-up effort, Gassen et al.[41], discuss how expertise differences for modellers need to be accounted for during facilitation. They present an experiment that tested how people with different levels of expertise work with different instructional material presented as automatic feedback of a tool. They found that guidance on reworking models needs to take different levels of expertise into account.

As has become visible in the descriptions given above, existing research either focusses on examining the facilitation of collaboration or proposes particular formats for the artifacts created through articulation. A link to the concept of scaffolding has hardly been made systematically in any of the reviewed approaches. This can be attributed to the fact that the articulation and modelling skills of the participants are (implicitly) assumed to remain constant throughout a workshop and the skill development in this area is hardly explicitly targeted in existing approaches. Still, using scaffolding as a lens to review existing approaches reveals that they already (implicitly) adopt structures or procedures that are used or could be used for scaffolding. Table 1 summarizes this review.

Table 1 shows that all the reviewed approaches provide different types of support for collaborative articulation and alignment via conceptual modelling that could be used as scaffolds. These support measures are deliver in

different forms and on different level of granularity. Hardly any study, however, explicitly addresses the fundamental principles of scaffolding. If at all, contingency is addressed via relying on a facilitator's expertise to adapt support

Table 1. Comparison of related work with respect to support of scaffolding.

| | Forms of proposed support usable as scaffolds | | | Properties of scaffoding adressed | | |
	Type of scaffold	Source of scaffolding	Means of scaffolding	Contingency	Fading	Transfer of responsibility
(Dean et al., 2000)	Procedural	Facilitator	Modeling	through facilitator's expertise		
(Santoro et al., 2010)	Meta-cognitive	Facilitator, Software	Questioning	through facilitator's expertise		
(Herrmann & Loser, 2013)	Meta-cognitive	Facilitator, Software	Questioning	through facilitator's expertise		
(Franco & Rouwette, 2011)	Strategic	Facilitator	Instructional Phase-model			
(Hoppenbrouwers & Rouwette, 2012)	Conceptual, Procedural	Facilitator, Software	Rules, Objectives in Phases			
(Tavella & Franco, 2015)	Strategic	Facilitator	depending on interaction style	through facilitator's expertise		
(Front et al., 2015)	Conceptual, Procedural	undetermined (Conductor?)	Instructional Phase-model			
(Hjalmarsson et al., 2015)	depending on facilitation style	Facilitator, Peers	depending on facilitation style	through facilitator's expertise	through different facilitation styles	through different facilitation styles

dynamically to the current articulation context. Only Hjalmarsson et al.[18] via their different facilitation styles explicitly recognize the need to fade support and transfer responsibility depending on the participant's expertise.

Fading and transfer of responsibility in the course of collaborative articulation and alignment of knowledge thus remain an under-examined aspect in the facilitation of such activities. In an effort to identify open research questions and identify indicative ways of approaching these questions, we report on an exploratory multiple case study in the following. The study has been conducted to identify the role of different kinds of scaffolds provided in the course of collaborative articulation and alignment via conceptual modelling.

4. Case Study

The articulation and alignment activities examined in this article imply the existence of a shared work context in which different mental models about collaborative work can develop. This shared work context, however, cannot be controlled or artificially created, as would be necessary for an experimental setup. Case study research[42] thus remains a suitable exploration strategy. The following paragraphs describe the fundamental research design for validation of the proposed concept. They are structured along Yin's components for designing case studies[42].

The following *research questions* can be derived from the aforementioned aim as a starting point for the empirical design:

- Q1: Which scaffolds can be provided during conceptual modelling to facilitate articulation and alignment?
- Q2: How can principles of scaffolding, such as contingency, fading, and transfer of responsibility, be implemented in collaborative conceptual modelling?

The case study strives to provide answers to these questions. They are concretized by two *propositions* that should be examined in the course of the case study:

- P1: Different types of scaffolds can be provided by different means to facilitate articulation and alignment.
- P2: Implementing principles of scaffolding in collaborative conceptual modelling can aid the development of articulation and alignment capabilities of participants.

These propositions will be critically reviewed in light of the outcomes of the case study in the next section. This review will enable to identify future directions of research in order to appropriately design scaffolding measures.

The *unit of analysis* for the case study is a group working together in the course of a single articulation and alignment session. The *data collection methodology* for testing the propositions needs to provide data that shows the relationship between the provided measures of scaffolding and the process and outcome of articulation. The interaction among people needs to be qualitatively assessed with respect to the evolution of an agreement that the common model adequately represents the collaborative work process and to which extent scaffolding measures have influenced this interaction process. Furthermore, data on the impact of the provided scaffolds on the resulting models is required. *Data interpretation* needs to look at the qualities of interaction in terms of evolution of agreement and whether or not the scaffolding measures deployed in the articulation activities or in the process of model creation had any impact on

these interactions. In addition, the modelling results need to be examined with respect to their adherence to structures that should be present when the scaffolds are used.

The case study has been designed to test the propositions following. Empirical methods have been chosen to meet the requirements on data collection set forth above. Both, the global case study design and the selected empirical methodology, are described in the following subsections.

4.1. Global Evaluation Design

Providing appropriate scaffolds for facilitating the collaborative articulation and alignment of mental models about work processes is highly dependent on the context of the examined group. A multiple-case design is thus necessary in order to validate the propositions formulated above.

For the purpose of carrying out the multiple case study, a modelling language designed for the purpose of articulation and alignment[10] has been augmented with different forms of scaffolding.

The modelling method aims at the development of a common understanding about a collaborative work process. It comprises several components that build upon each other. In a first step, a fundamental understanding of the concepts relevant for modelling is aligned (cf. Fig. 1, „setting the stage"). In a second stage, participants individually describe their perspectives on the work process from an activity-centric and interactional point of view (cf. Fig. 1, „individual articulation"). Finally, these individual models are consolidated to a shared model in the course of a collaborative effort to develop a common understanding about the overall work process (cf. Fig. 1, „collaborative alignment"). The modelling approach is described in more detail in our earlier research[43]. For evaluation purposes, focus is put on the third stage here, as it features a collaborative setting and makes use of a work-process-oriented modelling language.
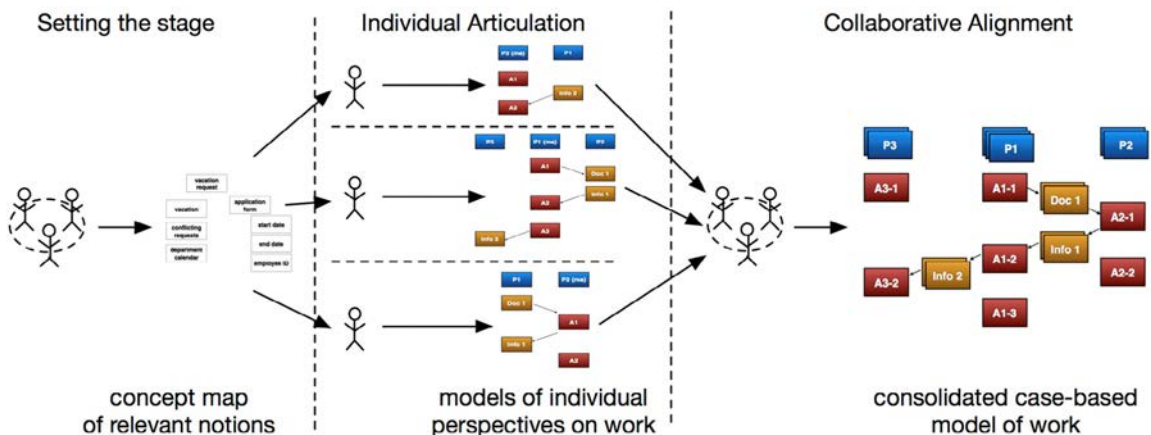

Fig. 1: Phases of used modelling method.

The following measures that can potentially be used for scaffolding have been developed and embedded in the modelling approach. Following the principles of scaffolding, their deployment needs to be decided upon based on the level of expertise of the participants.

- *S1*: conceptual types of modelling elements to be used for model articulation (blue … who, red … what, yellow … exchange of information or goods) - potential meta-cognitive scaffold
- *S2*: instructional phase model describing the sequence of phases to be completed during modelling (setting the stage > individual articulation > collaborative alignment) - potential strategic scaffold
- *S3*: textual description of modelling procedure for all phases, to be used by facilitator for guidance - potential procedural scaffold
- *S4*: graphical template for structuring model articulation and alignment using the same color coding as S1 indicating how to place modelling elements, to be used by participants - potential procedural scaffold

- *S5*: sample models giving concrete examples for potential results for all modelling phases, to be provided to participants - potential meta-cognitive scaffold
- *S6*: textually specified aims and rules on how to collaboratively create the model in phase 3, to be provided to the participants - potential strategic scaffold

4.2. Cases

The modelling language and the potential scaffolds described above are used as the foundation for all cases in the case study. The cases differ in which scaffolds actually were deployed and to which the principles of scaffolding were followed. They will be described in the following section.

The cases have all been carried out in the course of vocational training programs that were conducted in the context of the European Union-funded Leonardo da Vinci Project (FARAW; http://www.faraw.eu). Overall, 12 workshops have been documented using the methodology described above.

The aim of all documented workshops was to provide operative personnel with initial experiences to explicitly reflect on their daily work practices and their collaboration with others. None of the participants in either workshop had prior experiences with conceptual modelling or other forms of explicit articulation and alignment of knowledge about work processes. Data collection was carried out by the principal investigator of the project and support staff, who acted as observers in all 12 cases. The workshops were video-taped for later analysis of the articulation and alignment processes. The modelling results in all steps of the methodology were documented as photos.

4.2.1. Case Selection

Three cases have been selected out of the 12 documented cases. The three cases were selected to represent a diverse set of deployed scaffolds and different scaffolding strategies deployed by the workshop facilitators. They thus give a comprehensive overview about the observed phenomena:

- *Case 1* describes the method being used to reflect on the work to be carried out on the first day of internship in a care-home for the elderly. The participants were recruited in a vocational training program on care for the elderly in Austria, which is mainly taken by adults as a second-chance education. Students, school supervisors, and representatives of the care-homes reflected on the process. It was conducted by 11 participants working in two groups. The age of the participants ranged between 22 and 47, and eight participants were female and three were male. The workshop was facilitated by two trainers of the vocational training school, who had participated in a method-specific facilitator-training event previously. The following scaffolds were used: S1, S2 (all phases implemented), S3 (facilitator did not enforce procedure but supported on demand), S5 (sample models used by facilitator during introduction of phases), S6
- *Case 2* is taken from industrial production. The method was used to articulate and align mental models on the collaborative work process for tool production for a flexible manufacturing cell. The participants were toolmakers active in a factory in Slovenia. All participants had practical experiences with the tool production process from an operational perspective. Eleven participants contributed to the workshop reviewed in this case, all of whom were male and with an age range of 16 to 21. The workshop was facilitated by a foreman, who also was responsible for the company's training-on-the-job program. The foreman was a domain expert (i.e., was a tool-maker himself) and had participated in a facilitator-training event previously. The following scaffolds were used: S1, S2 (all phases implemented), S3 (facilitator did enforce procedure and chauffeured collaborative consolidation), S4 (provided to participants and to be use mandatory in phases 2 and 3).
- *Case 3* was carried out in the context of a vocational education program for social workers in the Netherlands. The method was used as a part of a reflection workshop on the practical experiences the students gained during an internship in street-work facilities. All students received practical experience organizing a street-dance workshop for disadvantaged young people and used the method to reflect on the process of organization. The 7 participants aged between 20 and 24 and had completed the second year of their three-year educational program. One of them was male whilst the remaining six were female. The workshop facilitators were social workers themselves, being active as domain expert teachers in the school. They had not participated in a facilitator-training event before their workshops, and prepared their workshop implementation based the materials provided as scaffolds. They only implemented the third phase of the method, omitting „setting the stage" and „individual

articulation". No procedure was proposed to the participant and no guidance was provided. Only the objectives of modelling and the fundamental rules for phase 3 were communicated. Consequently, the following scaffolds were used: S1, S6.

In the following, we describe the empirical methods used to analyze these cases.

4.3. Methodology

The two propositions call for an embedded case-study design, in which the relevant aspects of the cases are examined coherently using the same set of empirical methods for each case. In the following, we describe the empirical methods selected for assessing the research propositions. Selection of the methods is based on the requirements on data collection identified above.

4.3.1. Analysis of collaboration process

To make visible the effects of scaffolding on interaction in the course of a collaboration process, it is necessary to analyze the latter with respect to the different qualities in interaction necessary to archive a common understanding. As has been shown in our recent research[44], a variant of discourse analysis proposed by Weinberger & Fischer[45] can be used for this purpose.

In order to apply the approach of Weinberger & Fischer[45], the modelling process needs to be separated into distinct segments that can be evaluated with respect to the different dimensions of interaction. Our adaptation of method relies on an analysis of video recordings of collaborative workshops. Consequently, those recordings are segmented along the observable topics of discourse[19]. Putting the segments into relationships with the use of the provided scaffolds allows to examine their impact qualitatively.

The interaction of the involved actors is assessed in the following dimensions:

- The *participation dimension* refers to the quantity of contributions different people make. This includes the quantity of participation by each participant and the heterogeneity of participation.
- The *epistemic dimension* refers to the quality of contributions different people make. An initial distinction is made between on- and off-task discourses. On-task discourse is further distinguished in statements that are made (a) regarding the current problem space (i.e. the issue currently articulated), (b) the conceptual space (i.e. theoretical considerations about the issues at hand), (c) relationships between problem and conceptual space and their adequacy, and (d) relationships between the problem space and prior knowledge.
- The *argumentative dimension* goes beyond the quality of contributions and focusses on problem inquiry and resolution. It initially focusses on the identification and classification of claims made by the participants. Claims are distinguished according to whether they are (a) qualified (i.e. explicitly limited in their validity), (b) grounded, (c) qualified and grounded, or have (d) neither a limitation in validity nor any grounding warranting the claim.
- The *social-modes of co-construction* dimension rates the observed discourse with respect to how the participants work on the task and formulate arguments together. Discourse here is distinguished into phases that focus on (a) externalization of thoughts, (b) elicitation by questioning or provoking reactions, and consensus-building. Consensus-building can again take different forms: (c) conflict-oriented consensus-building presents participants with a critique and requires mutual assessment and adaptation of their positions. In contrast, (d) integration-oriented consensus-building is characterized by a take-over of positions, modifying positions based on the input of other participants. Quick consensus-building (e) does not contribute to knowledge construction and is characterized by an acceptance of other positions in order to move on.

These dimensions address different aspects of how people reach a common understanding about a problem. In the context of the present case study, the participants' contributions are classified along these dimensions. The presence of a certain quality is rated binary per segment. This means that each quality that has been observed at any time in a segment is recorded as being present in this respective segment. The qualities for each dimension consequently are not mutually exclusive per segment.
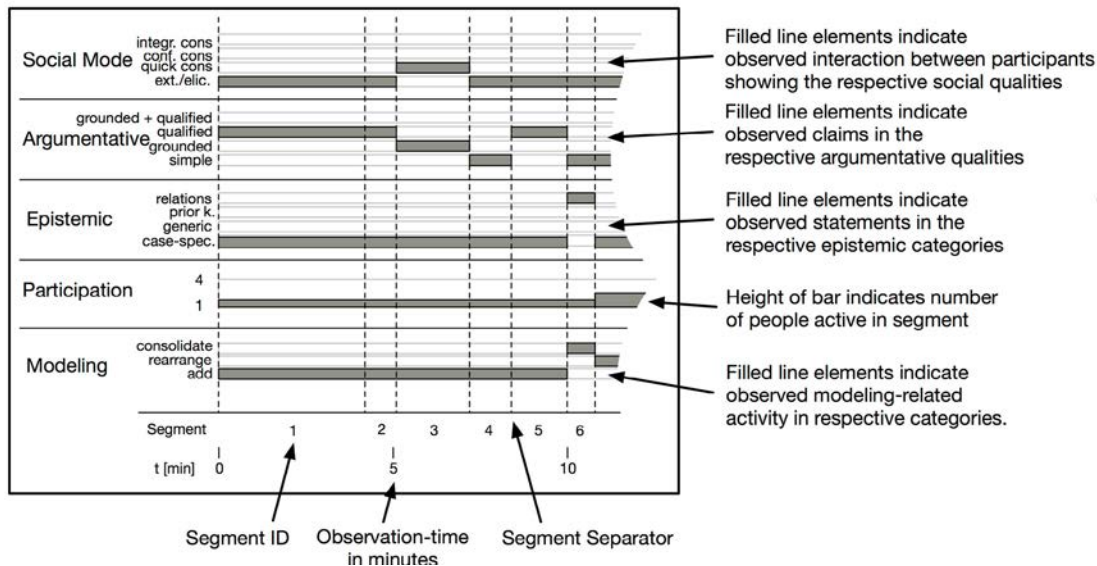

Fig. 2: Coding Scheme for Interaction Analysis.

The identified qualities per segment and dimension are visualized in the final aggregation step to allow for identification of relationships between the dimensions. Figure 2 shows the developed visualization. The data are presented along a horizontal timeline that additionally shows the identified segments and their duration. For each segment, the observed qualities are presented per analytical dimension stacked on the vertical axis. A solid bar indicates that the horizontally aligned quality has been observed in the respective segment.

For discussion of the results, only the visualization is included and qualitatively discussed in this paper. High quality of alignment activities should be indicated by a large amount of grounded and qualified claims in the argumentative dimension and phases of conflict-oriented or integration-oriented consensus-building in the social modes of co-construction. The participation dimension should show heterogeneous involvement of several participants whenever the qualities described above are observed. The epistemic dimension should show rising numbers of statements on the conceptual space as participants acquire conceptual modelling skills. However, the behavior in this dimension is influenced by the chosen modelling language and thus is not considered for further analysis here.

4.3.2. Analysis of articulation outcome

The collaboratively created model is analyzed with respect to whether it resembles the model structures outlines in S6, described in detail in S4 and exemplified in S5. Furthermore, the use of the semantic types of model elements proposed via S1 is checked.

Resemblance of the modelling layout rules has been checked based on the descriptions provided in S4, S5 and S6. The adaptation of the semantics of the modelling language elements has been assessed using methods of qualitative content analysis[46]. The model elements were semantically classified using a code book, which was generatively created from a set of sample models and iteratively revised if necessary. Using the pre-specified set of modelling elements for classification would be invalid here, as it would prevent the identification of semantic deviations. The

inter-rater reliability of the code-book was assessed using Cohen's Kappa. The first revision of the code-book led to a value of 0.506 when applied to a set of representative sample models. After a revision and clarification of the classification, another set of sample models were independently classified by two raters, reaching a value of 0.932 for Cohen's Kappa. The code-book was then used by the raters to classify the models produced as results of the workshops. For assessment of adequate use of the modelling language constructs, the results of classification were compared with the originally proposed semantics of the modelling language constructs.

The collected raw data was analyzed by graphically replicating the layout of the created model with abstracted model elements (cf. Figure 3). The blue elements (who?), serving as an anchor point for the other elements, were numbered consecutively. The red elements (what?) assigned to a blue element (if identifiable) were numbered consecutively starting from the element placed nearest to the according blue element, progressing outwards. Numbering follows the scheme "n.x", where "n" is the number of the blue element and "x" is the number of the red element. Yellow elements were numbered following the scheme "n-m.y", where "n" and "m" indicate the two connected blue elements and "y" is the number of the yellow element. For classification of the element semantics, a legend was created for each model. The legend indicates how the language constructs were semantically used in the model. If different semantics were used for one language construct (which is common for yellow elements, which can refer to information, documents, materials, etc.), they were differentiated using differently shaped outlines. Elements that were semantically fundamentally different from the remainder of the model elements of the same element type are explicitly marked and listed separately below the legend. Elements that could not be assigned a number according to the scheme above because of ambiguous layout are assigned a single Arabic numeral for unique identification. Figure 3 gives an example of an analyzed model (left: legend including list of semantically incorrectly typed elements, right: part of the replicated model layout).
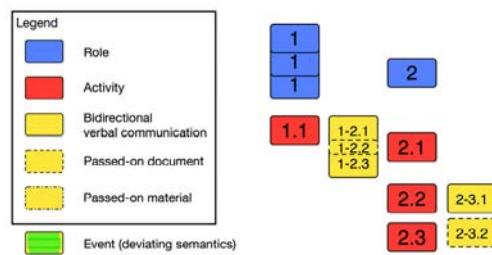

Fig. 3: Coding Scheme for Analysis of Modelling Results.

Scaffolding can be considered to be successful, if its outcome follows the structuring guidelines set forth in the structure-oriented scaffolds S4, S5 and S6. In addition, the semantics indicated in S1 should have been adhered to the resulting model.

5. Results

In the following, we describe the results of analysis for each case. Each case first is described regarding its interaction process followed by the outcome of the workshop. We close this section with a summary of our findings in the light of the research propositions formulated above.

5.1. Case 1

The first case was conducted in an Austrian vocational training school for adults being educated as carers for the elderly as described above.

5.1.1. Articulation Process

The recorded collaborative session lasted 35 minutes and 10 seconds (cf. Figure 4). In this duration, 28 segments were identified with lengths ranging between 20 and 255 seconds (median = 50 sec). Two of these segments contain off-topic interactions (as identified as part of the epistemic analysis), overall lasting one minute).
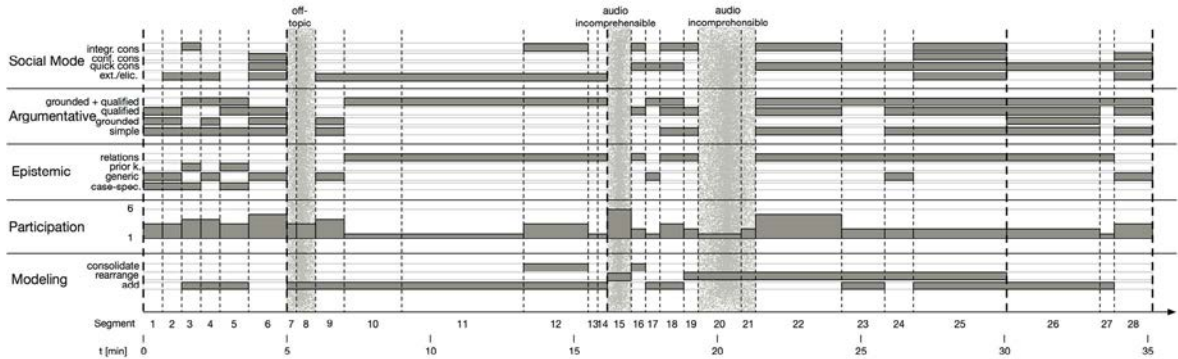

Fig. 4: Interaction Analysis of Case 1.

Four blocks of segments can be identified in this workshop. Segments 1-6 were largely dedicated to finding a common understanding of the scope of the process, which is indicated by a large number of active participants and a number of references back to generic knowledge about the work process. Social interaction focuses on externalization and elicitation activities with occasional consensus building activities.

Segments 7-14 cover the phase of individual participants articulating their individual contributions to the work process. This block is characterized by sequential activities of a low number of participants. The participants focused on relating their statements to their generic domain knowledge and consequently put much effort in grounding their claims and explicitly limiting their validity.

Segments 15-25 represent a phase of revisiting the initially articulated model, and are characterized by re-arranging of the model to reflect the outcomes of the consensus-building activities happening in parallel. Segment 22 shows involvement of a large number of participants, which is due to a phase of collaborative reflection of the articulated model. This evolves into a dialogue between two participants in the later segments, who took initiative and tried to identify still unclear aspects via consensus-oriented argumentative moves.

The final block began in segment 25 (thus overlapping the former macro-segment) and covers the phase of reflecting the identified clarifications by adding further elements to the model to refine it. The last segment covers the wrap-up session in which a walkthrough was performed using the final model.

5.1.2. Modelling Result

Figure 5 shows the transcribed modelling result of case 1. The modelling guidelines have largely been applied, with some ambiguity in the assignment of yellow elements to red elements, and one yellow element (5.5) placed in line with the red elements of blue element 5.

The semantics of the modelling language constructs are used consistently with one exception. Element 5.5 was chosen to be a yellow element (indicating exchanged information) but semantically was used to describe an event (reading - translated by author - "initial training finished"). As the modelling language does not provide constructs to describe events, this is to be considered an extension of the language rather than an inconsistently selected language construct. The yellow element was used in three different meanings. The participants mostly modeled direct bi-directional communication, which is carried out orally (i.e., "conversations"). In two cases (elements with dashed outline) they explicitly modeled the passing of documents, and in one case (element with dash-dotted outline) they considered the exchange of materials to be relevant.
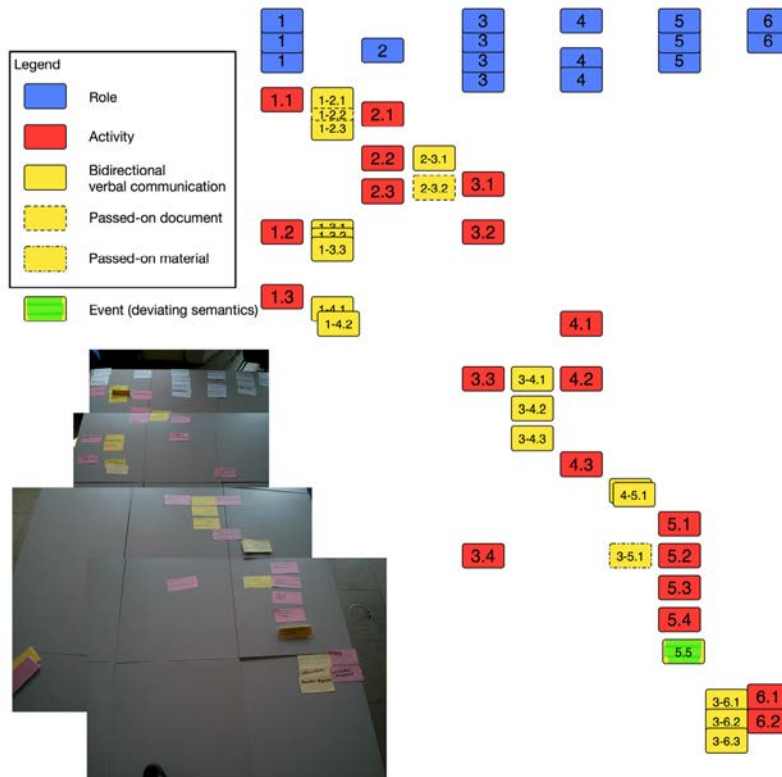

Fig. 5: Modelling Result of Case 1.

The application of scaffold S3 should lead to binary sets of matching yellow elements (one provided by the sender and one provided by the receiver). This pattern, however, is only observable in one case here (element 4-5.1). The other elements have only been provided by one of the participants, but were mutually accepted. This can be attributed to the different levels of detail used by the participants when describing their interaction. The participants representing the blue elements 1 and 3 in particular described their interaction with others in much detail, whereas the other participants remained more abstract and provided yellow elements labeled "conversation", for example, which were not included in the model during collaborative consolidation. The expected layout of matching elements can be observed for the blue elements, where matching elements were physically stacked. The communication hub of the work process can be visually identified in element 3, which is to be expected content-wise, as element 3 represents the intern who progresses through the different departments of the care-home.

5.1.3. Impact of scaffolding

Overall, the discourse analysis depicts a process which is representative for workshops that are facilitated using the guidance scaffold specified in S3 mostly on demand, i.e., only providing assistance to the participants when they request it. A stronger intervention by the facilitator only was necessary after the initial phase of consolidation (off-topic interaction in segments 7-8), when participants were unsure how to continue consolidation. S5 (sample models) was deployed to provide support here. The support via S3 was faded subsequently, and it was the participants' responsibility to ask for support when required. However, with repeatedly consulting S6 (rules and objectives), they managed to complete the task on their own. The low amount of consolidation activities during modelling (e.g. matching model elements and removing duplicates), however, was not expected given that element consolidation is an integral part of the methodology when specifying the interfaces among the participants of the work process. In the present case, the lack of alignment activities can be attributed to the behavior of the participants, who used different levels of detail when describing their work contribution and interaction, which led to complementary rather than conflicting yellow elements. Still, intervention via S3 might have helped to trigger further alignment activities (aside quick consensus building) and led to higher involvement of more participants.

5.2. Case 2

The second case was documented in a workshop carried out in the context of a training session on shop-floor logistics in an industrial production company in Slovenia as described above.

5.2.1. Articulation Process

The recorded collaborative session lasted 21 minutes (cf. Figure 6), during which 15 segments were identified with lengths between 40 and 210 seconds (median = 60 sec). No off-topic discourse was identified, and the entire session was dedicated to discussing the work process.
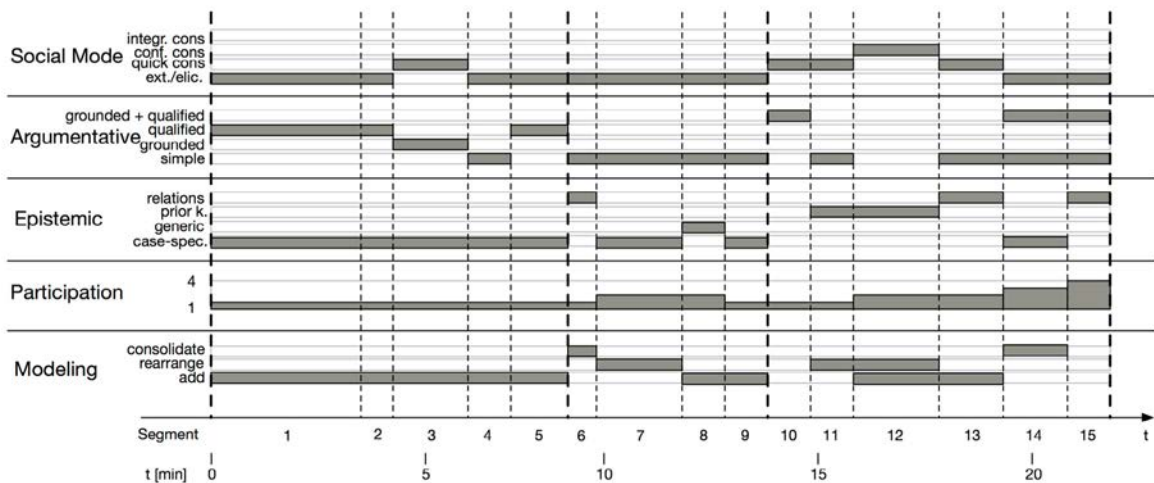

Fig. 6: Interaction Analysis of Case 2.

Three blocks of segments can be identified in this workshop.

Segments 1-5 cover the phase of individual participants articulating their individual contributions to the work process. The participants were active sequentially one at a time and focused on externalizing their concrete experiences with the work processes.

Segments 6-9 represent a phase of revisiting the initial version of the complete model and rearranging elements for clarification. Participants here also settled on their interactions sequentially in a one-to-one setting. The social mode

of interaction is still externalization and elicitation, as no unclear situations were identified that would have required resolution.

The final block starts in segment 10 and is dedicated to generalizing the model by referring to prior knowledge. This is the only block that shows more extensive consensus-building activities, as experiences with the work process were fundamentally diverging and the facilitator left room to align these views. After resolution of their different viewpoints, the participants consolidated the model again, removing redundancies and finally collaboratively revisited the final result by discussing it step-by-step.

5.2.2. Modelling Result

Figure 7 shows the transcribed modelling result of case 2. The modelling guidelines are adhered to in principle. The participants used arrows to indicate explicitly the source- and target-elements of yellow elements. While this is not part of the scaffolds, it is to be considered a useful extension to assign unambiguously yellow elements to red elements.

The semantics of the modelling language constructs are used consistently in all model elements. The ignorance of the structuring scaffold S4 (template) between elements 1 and 2, however, can be attributed to a perceived lack of expressiveness of the provided modelling constructs. Yellow elements were strictly used for explicitly passed artifacts, such as documents (elements with dashed outline) and material (elements with dash-dotted outline). When the participants wanted to express direct conversation between blue elements 1 and 2, they did not use a yellow element (as in case 1) but rather placed the corresponding red elements next to each other (elements 1.1 and 2.1). While the meaning was clear to the participants, the model lacks an explicit representation of this conversation.
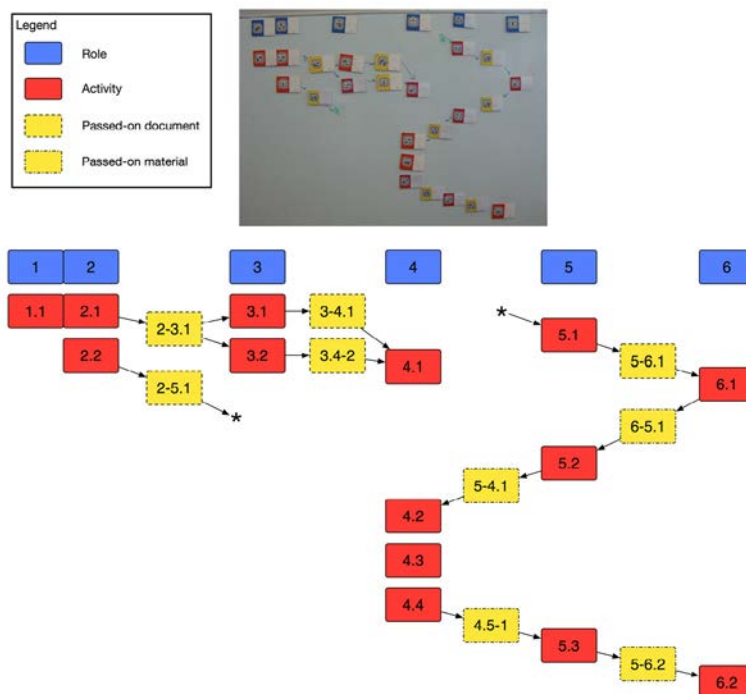

Fig. 7: Modelling Result of Case 2.

Stacks of matching elements are not present at all in the model of case 2. This, however, is to be attributed to the facilitator, who only accepted one single card for each model element and omitted matching cards for reasons of clear visualization. The amount of matching blue and yellow elements thus cannot be identified in the model and can also

not be derived from the video recordings of the workshop, as participants stopped offering matching cards to the others after the initial intervention of the facilitator.

5.2.3. Impact of scaffolding

Overall, the discourse analysis depicts a process which is representative for workshops that are strongly guided and following the scaffolds is enforced. Similar results have been observed in all other cases that were observed with facilitation that left little degrees of freedom. As in case 1, the low amount of consolidation activities is not to be expected from a methodological point of view. In the present case, this can be attributed to the facilitator, who only accepted one single card for each model element already during articulation (i.e., in segment block 1) and omitted matching cards for reasons of clear visualization. The strong guidance of the facilitator based on S3 and the mandatory use of S4 (model structuring templates) basically lead to the targeted modelling result in terms of layout and also the interaction process resembled the expected phases. Still, alignment activities remain underrepresented throughout most of the modelling session. Only in the final segments (starting from segment 10) when the initial model version was basically finished and the facilitator faded its guidance (which was strongly focused on building the model), involvement of participants rises and higher-quality alignment activities are observable (cf. social mode and argumentative dimension in Figure 6).

5.3. Case 3

Case 3 was taken from a series of workshops conducted in a vocational education school for social workers in the Netherlands as described above.

5.3.1. Articulation Process

The recorded collaborative session lasted 35 minutes and 40 seconds (cf. Figure 8), during which 12 segments were identified with lengths between 45 and 255 seconds (median = 187.5 sec). Two of these segments contain off-topic interactions (as identified as part of the epistemic analysis), overall lasting seven minutes and 10 seconds.
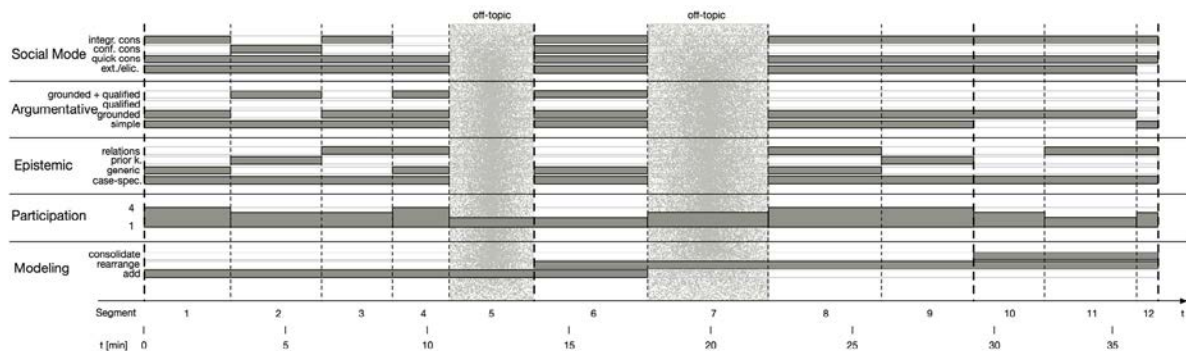

Fig. 8: Interaction Analysis of Case 3.

Three blocks of segments can be identified in this workshop. Segments 1-6 were largely dedicated to externalizing relevant model elements and collecting them without defining any relationships among them. As neither the setting-the-stage-phase nor the individual-articulation-phase were implemented in the present case (due to a lack of methodological guidance by the facilitator - cf. below), most of the externalization activities usually covered in these phases were covered in this block. This also justifies the longer duration of segments when compared with the other cases. Involvement of the participants was high and was characterized by a high effort in providing justifications for the contributed model elements.

Segments 6-9 cover the phase of ordering the elements just articulated. Participants here discussed, how to arrange the elements and put them into spatial relationships. These activities were mainly initiated by two participants, whilst

others joined in after methodological questions had been resolved in cooperation with the visiting principal investigator, who acted as an observer (off-topic interaction in segment 7). The requested intervention of the principal investigator encouraged the participants in their way of articulation and consolidation although it did not follow the procedures specified in the method-guidelines. At the end of segment 9, one participant started to add structure beyond spatial arrangement by connecting the elements with arrows. This was picked up by the other participants and shifted the focus to the quality of the relationships among the elements.

The topic of relationships was discussed in the final block of segments, starting from segment 10. Participation declined again here, while argumentation about which relationships are valid under certain circumstances remained high. In a final effort in segment 12, the whole model was revisited cooperatively to reach a consensus about the communication channels to be used in the work process (cf. section on modelling result below).

5.3.2. Modelling Result

Figure 9 shows the transcribed modelling result of case 3. The scaffolds aiming at structuring modelling were not used in this case. The model layout does not allow the unambiguously assignment of red elements to blue elements and yellow elements to red elements. The participants used arrows to indicate causal and temporal connections between elements, but did not follow a consistent linking approach.
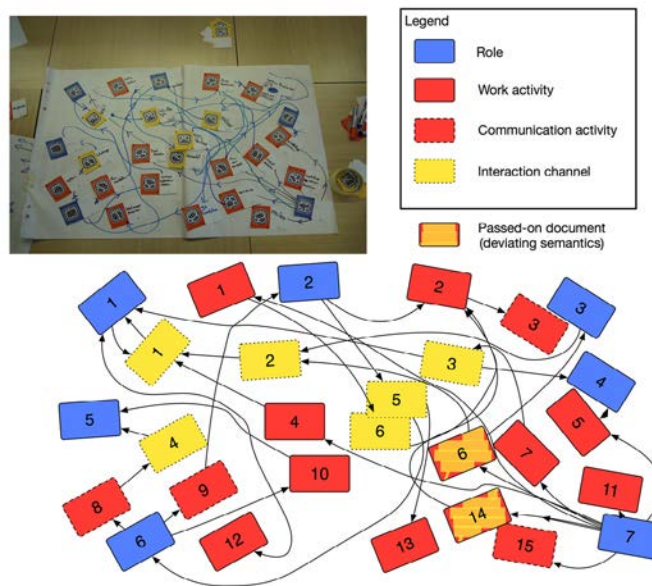

Fig. 9: Modelling Result of Case 3.

The semantics of blue elements were used consistently, while red elements were used to describe work activities (as proposed) but also to encode communication, as the participants described activities that involved interacting with others. This is consistent with not assigning red elements to single blue elements but rather partially using them as links between blue elements (e.g. red element 9, which - as a communication activity - connects with blue elements 6 and 2). Consequently, communication was not represented using yellow elements. The now superficial yellow elements were used to represent interaction-channels (such as "email" or "orally", etc.). An example of these semantics can be found between blue elements 5 and 6, where the communication activity represented by red element 8 is carried out using the communication channel represented by yellow element 4.

Following the ambiguous use of red elements for representing communication acts, two semantic deviations have also been introduced with red elements 6 and 14, which represent exchanged documents and thus do not fit in the case-specific interpretation of the modelling language.

Content-wise, the transcribed model does not expose any visible hints at communication hubs or coordination activities. When untangling the drawn arrows using computer algorithms for graph layouting, it becomes apparent

that the role represented by the red element 7 is the central point of work and communication in the work process, which makes sense content-wise, as the blue element 7 represents the main organizer of the event.

5.3.3. Impact of scaffolding

Overall, the discourse analysis shows that the process in this workshop has been less structured than in the other two cases. The suggested layout for model creation was ignored in this case (cf. section on modelling result below), as was the phase of individual articulation. Both aspects can be attributed to a lack of deployment of any of the scaffolds that allow for strong intervention in the articulation and alignment process (e.g., S3, S4 or S5). Participants were fully responsible for the modelling process and outcome form the beginning on, and no fading could be observed. Still, the fundamental aspects to be expected during collaborative alignment are visible in the analysis of the present case. The rather unstructured approach of externalization is accompanied by a large amount of consensus-building activities. This can be attributed to the heterogeneous experiences of the participants, who were involved in the same work process at different institutions (as described above) and consequently contributed fundamentally different views on a case-specific level. Also, they were aware about the rules and objectives set forth in S6, and — although they partially ignored them in terms of structuring the model — they followed the objective of aligning their different mental models about their work processes. The two off-topic segments (5 and 7) contain interaction with the principal investigator, during which an unplanned conceptual scaffold to motivate the relevance of the workshop was provided upon demand by the participants. As is visible in Figure 8, the amount of participation rose immediately after these interventions.

5.4. Comparative review of scaffolding measures

The modelling results generated in the three cases are heterogeneous regarding the amount of scaffolding deployed and the implementation of scaffolding principles.

The facilitator in case 2 has strictly followed and enforced the proposed scaffolds and has largely refrained from fading and transfer of responsibility. His strict guidance did not allow for contingency to arise or at least become visible. The modelling result shows consistently assigned semantics for all model elements. It is the only case in which yellow elements are consistently used for directed interaction (i.e., have an identified sender and recipient) and are solely anchored on red elements as devised in the structural guidance description provided via S3 and S4. However, the strict guidance seems to have prevented alignment activities to be conducted by the participants.

The facilitators in case 1 have taken a more liberal approach in providing scaffolds and eventually faded support measures. Modelling results in case 1 largely adheres to the modelling guidelines but introduces yellow elements that represent bi-directional spoken communication, which was not anticipated in the original language specification provided in S1, S3 and S4. However, more and higher quality alignment activities could be observed in case 1 than in case 2. The deployment of S6, where alignment was explicitly mentioned as an objective, might have been supportive here.

In case 3, no scaffolds were provided by the facilitator at all, and participants had to rely on textual or graphical scaffolds provided via S1 and S6. Presumably due to the lack of further guidance, participants in case 3 have taken on an even more fundamental re-interpretation of the yellow elements than in case 1, using them consistently to represent different communication channels. Consequently, the red elements have been used to not only describe individual activities, but also communication activities. Linking the elements in case 3 appears to be largely arbitrary but was backed with meaning that has been articulated during the workshop following the objectives provided in S6. The lack of procedural guidance in combination with S6, however, seems to have led to the intended behavior of articulation and alignment of mental models. However, as the large amount of simultaneous activity and the limited argumentative quality indicates, the level of maturity in interaction reached in case 1 could not be reached in case 3. This, in turn, can again be attributed to the lack of structuring interaction via scaffolding by a facilitator following S2 and S3.

Cases 1 and 3 also show some elements with deviating semantics. These were identified when elements were used for representing a concept, which — when considering the case-specific semantics — should have been modeled with another kind of element. In case 1, an "event" was modeled using a yellow element, whereas in case 3, a "document" was introduced using a red element. In both cases, the case-specific interpretation of the modelling language did not

allow for consistent representation of such elements and thus required the re-interpretation of another, already used element. This however, hints at a limitation of the used modelling language, which was specified via S1.

6. Discussion

The results of the case study allow to derive indicative findings regarding the propositions formulated above.

P1 („Different types of scaffolds can be provided by different means to facilitate articulation and alignment.") is backed by the findings from the case study. Although different scaffolds were used in the different cases, which differed in the used means and channels of delivery, the fundamental goal of facilitation articulation and alignment could be reached in all three cases. Still, the quality of the results varies in relation to the type of scaffolds provided. There appears to be no single type of scaffold in the case study that provides structure to the articulation process and still enables comprehensive, in-depth alignment activities. This finding appears to be connected to P2.

P2 („Implementing principles of scaffolding in collaborative conceptual modelling can aid the development of articulation and alignment capabilities of participants.") also appears to be backed by the findings of the case study. Only in case 1, contingency, fading and transfer of responsibility were actively implemented by the facilitators. This case shows a structured modelling result while at the same time having exposed a large amount of high quality alignment activities. The behavior of the participants indicated that they acquired structured articulation and alignment capabilities at least to some extent and were able to identify situations in which they required support through the facilitator. The facilitator in case 2 largely refrained from fading and transfer of responsibility, which led to a particularly low amount of alignment activities. Participants consequently remained in a passive role, only becoming active when explicitly questioned by the facilitator. Interaction among the participants only rose in the final phase of the workshop, where the facilitator intervened less. Still, the amount of high-quality alignment activities remained low also in this phase. Case 3 can be considered to fully contrast case 2. Participants received no active guidance at all and had to rely on a limited set of scaffolds provided via workshop materials. This led to ignorance of the proposed structuring approach and an intermediate phase of fundamentally questioning the workshop objectives, which could only be resolved by a requested intervention of the principal investigator, who offered a conceptual scaffold to motivate the tasks the participants were confronted with.

The findings of the case study are largely in line with those that could be expected based on prior research available in related work. Still, explicitly using a scaffolding lens when designing the case study has allowed to identify potentially critical aspects that should be considered when pursuing the aim of using scaffolding to support the development of articulation and alignment capabilities.

First, the case study has revealed that passive scaffolds such as provided materials cannot substitute active scaffolding activities. In the case study, these activities are carried out by human facilitators. Related work, however, actively looks into using software to provide scaffolds to participants. Successful scaffolding, however, is context-depended and needs to be adapted to the situation and needs of the modelers. This poses the question how software could capture appropriate information that allows to derive potential needs for scaffolding.

Second, the case study also indicates that the development of capabilities through scaffolding is largely dependent on the capabilities of facilitator to actively deploy the fundamental principles of scaffolding. This capability also must not be assumed to be available and requires training and experience. This poses the question of how facilitators could be trained to appropriately deploy scaffolding in articulation and alignment activities.

Third, the different forms of scaffolding deployed in the case study have been provided by different sources. Strategic scaffolds have been successfully delivered via textual or graphical descriptions. Procedural and metacognitive scaffolds, however, were only successfully deployed when provided by the facilitator or the participants themselves. These results, however, are only indicative and require further examination. The question here consequently is, whether the effectiveness of different forms of scaffolding is linked to different sources delivering the scaffolds. Eventually, this leads to the question, if a facilitator could be substituted by other means of providing scaffolds in the specific use case or whether human intervention is indispensable.

7. Conclusion

In this paper, we have discussed how the concept of scaffolding can be used to support the collaborative articulation and alignment of mental models. We have shown that — while the concept of scaffolding is hardly explicitly adopted in the current state-of-the-art — recent research arguably points out the importance of examining ways to build articulation and alignment capabilities via conceptual modelling for people usually not concerned with such topics in their operative field of work[18][47]. Our case study indicates that principles of scaffolding can be effectively deployed for this purpose and points at potential critical success factors. These indicative success factors allow to further explore the potential value of scaffolding for interventions triggering individual and collective learning in organizational problem solving processes[4].

The findings derived in this work, however, are of limited validity, as the study has not considered potentially interfering variables, such as the social setting in the groups, which might have affected willingness for alignment and thus might have interfered with the effect of scaffolding. Still, the indicative results are sound and in line what should be expected based on the results of related studies in the field of facilitating collaborative modelling[34][19][38]. They thus have been used to derive further research questions, which will direct our future research.

Following a design science approach[48], we will start with elaborating on question 1 and build an initial software artifact that should support scaffolding the process of articulation and alignment of mental models about work. This prototype will allow to investigate question 3 and trigger an iterative refinement process of the artifact. Refinement of the artifact with respect to how it provides scaffolds will eventually also enable to study question 2 and transfer findings back to the field of educational science.

Acknowledgements

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