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Collaborative open analysis in a qualitative research environment

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One goal of open science is making research processes like analysis more open and traceable. To contribute to this aim, we designed an open digital research environment based on Semantic MediaWiki technology to be used for the qualitative collaborative analysis method of objective hermeneutics. The environment was used in university seminars in which students learned the analysis method in a research-based learning setting. This article examines added values of open analysis in learning and teaching of qualitative research methods. It outlines the potentials of the environment like guiding students through digital structures, and retracing the collaborative interpretation processes, but as well discusses the pedagogical boundaries of open online collaborative work.

Keywords: Open science, open analysis, research-based learning, digital research environment, semantic MediaWiki, objective hermeneutic, qualitative data analysis, open education

1. Introduction

Open science imparts as an umbrella term a new momentum in the debates about the digitisation of science and research ranging from collaboratory to cyber science, cyberinfrastructure and eScience and Science 2.0. Following more explicitly the characteristics of the "open" movement, open science focuses on the capacities of accessibility, transparency, sharing, and collaboration. It encompasses a range of concepts like open access to scholarly publications, open research data, open source research software, open methods, citizen science, open educational resources, and transparent alternatives for research evaluation and peer review (Pontika et al., 2015). Nevertheless, aside from the successful proliferation of the term "open science", the concept is described as being abstract, vague, diverse, and entangled with several perspectives and assumptions (Scheliga & Friesike, 2014; Fecher & Friesike, 2014; Grubb & Easterbrook, 2011), whereby a "one-size-fits-all" concept is applied consistently across disciplines (Levin & Leonelli, 2017). Studies have therefore emphasized the need to recognise openness community-specifically and epistemologically,

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embedded in research practice (Levin & Leonelli, 2017; Whyte & Pryor, 2011; Lyon et al., 2010).

Recently, an EU report defined learning and teaching as crucial for a broad realisation of open science and identified the need for an adequate discipline-dependent skills training for researchers at all stages of the professional career (O'Corroll et al., 2017). First projects have realized training tasks at the European level with dedicated workshops (Brinken et al., 2019). Others create courses at university level (Toelch & Ostwald, 2018) or emphasize the central role of research-based learning in open science (Heck & Heudorfer, 2018).

This article focuses on a concrete epistemological research practice conducted in Social Sciences, Humanities and Education, where capacities of open science, especially open analysis, are still emergent and in flux. While the re-usage of qualitative research data is increasingly being established (Bishop & Kuula-Luumi, 2017), several authors have indicated a lack of available digital tools for enabling open analysis in qualitative research (Conrad, 2018; van der Zee & Reich, 2018).

Triggering the qualitative research process, we designed a digital research environment to apply the qualitative research method of objective hermeneutics (Steinhardt, 2018; Veja et al., 2017; Schindler et al., 2017). Objective hermeneutics implies collaborative group interpretations and is taught in several university courses in Germany.

As a first case study, we evaluated the use of our digital environment in two seminars that aimed at teaching objective hermeneutics in a research-based setting. We examine the potentials and boundaries of open analysis in a learning and teaching context and pursue the following research question: What potentials and boundaries does open analysis offer for qualitative research?

In Section 2 of this paper, we describe the current state of research concerning open science in qualitative research and in research-based learning. In Section 3, we outline the concrete case of open analysis in objective hermeneutics. We then characterise the design of the research environment for conducting objective hermeneutics. Added values of open qualitative analysis in a research environment are focused in Section 4, and Section 5 describes the settings and the outcome of the evaluation. Finally, we offer a summary and outlook in Section 6.

2. Research context

2.1. Openness in qualitative research

Qualitative research communities started to discuss open science in a broad sense and articulate respective requirements, leading to a discussion and establishment of qualitative data practices and research infrastructure developments (Tamminen & Poucher, 2018; Nelson, 2017; Bambey et al., 2017; Corti & Thompson, 2006). Tamminen and Poucher emphasize the benefits for qualitative inquiry by concretising the

greater transparency of qualitative inquiry itself: "sharing the detailed process surrounding one's interpretations in a qualitative study can enable audiences to identify the contextual features of the work, allowing them to understand how the researchers developed their interpretations" (Tamminen & Poucher, 2018, p. 24). Additionally, they highlight the potential to collaboratively interpret the same data and the possibility to get pluralistic analyses (Tamminen & Poucher, 2018, p. 24). At the same time, the researchers problematize that open science often implies scientific postpositivist approaches like replicability, controlled research, and statistical generalizability, which create epistemological boundaries for adoption (2018, p. 23). Tsai et al. (2016) argue in a similar vein, while hinting at the dominance of the reproducibility paradigm in data sharing. Nelson has analysed several studies that used collaborative approaches and retracing possibilities in qualitative research, and articulates the main challenges in qualitative research in terms of legal issues, privacy protection, and the risk to lose the approval of informants (Nelson, 2017, p. 15). He strictly argues in qualitative research for the openness of everything, with everyone at any time (Nelson, 2017, p. 15).

Drawing a comparison to quantitative research, van der Zee and Reich argue for more transparent research processes in qualitative research by "making publicly available more of the underlying data, coding schemes, examples of coded data, analytic memos, examples of reconciled disagreements among coders, and other important pieces that describe the underlying analytic work leading to conclusions" (2018, p. 10). Tsai et al. (2016) argue for an export of the coding queries, because they "consist of excerpted and possibly disembodied interview text, they may offer greater anonymity compared with full transcripts". While a common establishment of open analysis in qualitative research is so far not apparent, the current discussions are a basis for this article, where we focus on epistemological potentials of open analysis, like transparency of the research process (retracing) and collaborative interpretation of research data.

2.2. Openness in research-based learning

In qualitative research communities, research-based learning approaches play a central role for the pedagogical professionalization of teaching research and its methods (Kilburn et al., 2014). Some studies exemplify the potentials of open science in learning and teaching qualitative research in the context of re-using research data, especially in research-based learning approaches (Haaker & Morgan-Brett, 2017; Elman et al., 2015; Bishop, 2012). To address the potentials of openness in qualitative research for learning and teaching, the relation between research-based learning and openness is examined in the following, focusing on pedagogical capacities and boundaries of required environments.

Research-based learning (Healey, 2005) or related concepts e.g. inquiry-based learning (Levy, 2009) are discussed in a variety of forms which relate research to learning and teaching. In this article, we want to focus on the students' activity of

"doing research" and restrict research-based learning to these aspects and the relevant capacities for realising potentially a complete research lifecycle (Reinmann, 2016, Huber, 2009).

Heck and Heudorfer have analysed openness in research-based learning (in German: "forschendes Lernen") and identified the degrees of students' autonomy and independency in learning environments as topical aspects (2018, p. 84). Based on (Brew, 2013; Hackling, 2005; Lübcke et al., 2017), they argue that the capacities of self-regulated learning and action vary in relation to the openness of the learning environment. Thereby, the agency is transferred from the lecturer to the student (Heck & Heudorfer, 2018, p. 84).

Reinmann has specified the pedagogical capacities and boundaries for designing research-based learning environments, and identified three dimensions which interfere partially but offer a focused analytical frame: 1) "learning about research", 2) "learning for research" and 3) "learning through research" (2016, p. 333). Each dimension focuses on different activities, resulting in different academic tasks in scholarly teaching. Reinmann describes the dimension of 1) "learning about research" as a space of information, where students are informed with a receptive knowledge transfer model of showing or pointing to research. "Learning for research" (2) by contrast needs a space of testing, where students prepare research and are activated to do research through rehearsing. Furthermore, the dimension "learning through research" (3) creates a space of exploration, where students are productive, discover, and are mainly guided through research. While learning through research can take different forms, Reinmann emphasizes as a main characteristic that students need to recognize the complete research life cycle (2016, p. 237). In each case, learning environments increase the students' participation in research (1: receptive, 2: rehearsing, 3: productive), whereby the learning environments enact primarily aspects of 1) mediating, 2) activating, and 3) guidance (2016, p. 336).

While 'doing research' is crucial for learning and teaching of research, Reinmann describes adequate pedagogical requirements for research-based learning environments. Especially, the dimension "learning through research" (3) explicates the central pedagogical affordance of a space of exploration, where students can participate in scientific knowledge production and discover new insights. Besides this openness concerning the autonomy and independency of students in research, Reinmann also indicates the central role of guidance through research by the environment and the lecturer.

3. The case and the research environment

3.1. Objective hermeneutics as a case of open analysis

The method of objective hermeneutics, a form of conversation or interaction analysis, was chosen as a case of qualitative research. Established in the 1970s, objective hermeneutics became one of the main methodologies in qualitative data analysis in German-speaking countries. Objective hermeneutics analyses the structure

of the case as the outcome of interaction by speech acts. The methodology claims to explicate these structures by a collaborative, sequential, multi-layered process of interpretation based on research data interaction protocols (Wernet, 2013; Oevermann, 1981). Concerning open science, objective hermeneutics is an interesting case because it is one of the few approaches in qualitative research which follow a dedicated collaborative analysis process and data sharing practices where a group of researchers is involved.

The analysis process in objective hermeneutics is as follows: The object of analysis, i.e. the case, are printed protocols of social interactions, for example transcripts of interactions in a class room. The analysis is realized by a small group of researchers. The researchers' collaboration is central for the whole analysis process because the aim of objective hermeneutics is to consider multiple perspectives of interpretations. At the beginning of each collaborative analysis step, the researchers agree on a short text snippet of a protocol to be interpreted. Then, they start a stepwise multi-layered process of interpretation:

a) The researchers create decontextualized and alternative stories (German "Geschichten"), where the chosen text snippet could be an adequate statement.
b) Afterwards, the researchers create and discuss several diverse readings ("Lesarten") of the text part.
c) Then, 'connections' ("Anschlüsse") are created, which describe possible follow-up situations.
d) Finally, the readings and interpretations are compared to the actual context of the protocol for re-contextualisation ("Kontextualisierung").

Those sequential analyses are done continually for each following text snippet, they create patterns of interpretation and the researcher discussions serve to validate the interpretation. At the end, the insights from the discussions are condensed to a case structure hypothesis ("Fallstrukturhypothese").

In objective hermeneutics, five common methodological principles form the interpretational acts and the interaction with the protocol: Principle 1) 'interpret sequence by sequence' directs the sequel analysis and prevents previewing of the following sequences. Principle 2) 'exclude the context' leads to the first step of interpretation 'stories' and aims at a decontextualization of the concrete examined situation. Principle 3) 'take the literal meaning of a text seriously' demands for a careful reading and a close coupling of the interpretation with the concrete text. According to principle 4) "extensively", the space of interpretation is extended, while a range of possible meanings of the segmented text are created. Principle 5) "Thriftiness" limits and validates the space of interpretation by excluding fictional interpretations which are not plausibly supported by the text (see Wernet, 2000, 2013).

3.2. Design of the research environment for open analysis

We developed a digital tool based on Semantic MediaWiki to enable researchers to collaboratively conduct an objective hermeneutic analysis online and time- as well

as place-independently. This open research environment[1] is situated in the current landscape of open science tools. There are still gaps and opportunities for new or improved digital products in the scope of heterogeneous research processes, especially with respect to qualitative analysis. Kramer and Bosman (2016), and Conrad (2018) analysed available digital tools. Many open tools support searching, archiving and sharing of data and publications, as well as publishing and outreach processes. The studies indicate that existing tools are not fully compliant to open science and often lack aspects of usability, accessibility, or interoperability with other systems. Concerning the need to address specific research practices and their life cycles, "there are big gaps in, and strong demand for, open tools to support qualitative or mixed methods research" (Conrad, 2018). The development of a research environment for objective hermeneutics was motivated by this digital gap in qualitative research, aiming to address capacities and boundaries of digital practices in qualitative research.

To realise the research environment, we followed a participatory and evolutionary design approach with an agile development framework. A group of qualitative researchers from different German research institutions and universities actively participated in the design process, which took about a year. The multi-disciplinary team of educational scientists, information scientists and software developers organized fortnightly meetings and realized an ongoing requirement analysis and an evolutionary development with three workshops and a rapid prototyping, where researchers continuously tested the environment.

This research environment is based on Semantic MediaWiki[2] and the new Objective Hermeneutic Interpreter Extension (OHI).[3] The technical framework and the usage of semantic web technologies for qualitative research are described in detail in the paper of Veja et al. (2017). The research environment was published as an open software and is re-used in the project "Collaborative Online Interpretation", funded by a Wikimedia research program (Steinhardt, 2018).

4. Potentials of open analysis

The digital research environment offers a new specific configuration of methodological practices for interactions between researchers and research data. The environmental design considers the common methodological ground of objective hermeneutics (Wernet, 2013; Oevermann, 1981). Figure 1 illustrates the designed analysis process as a workflow from the interaction protocol (tab "Transkript"), via the sequel analysis with segmentation and step-wise, multi-layered interpretation (tab "Interpretation" to "Kontextualisierung"), to the outcome of the analysis – the iterative creation of a valid case structure hypothesis (tab "Fallstrukturhypothese").

[1] In this article, we use the term "open research environment" in accordance to virtual research environments to emphasize the open facility and the recognition of the research life cycle (Fraser, 2005).

[2] https://www.semantic-mediawiki.org/wiki/Semantic_MediaWiki.

[3] https://semantic-cora.org/index.php/Documentation/OHITool.

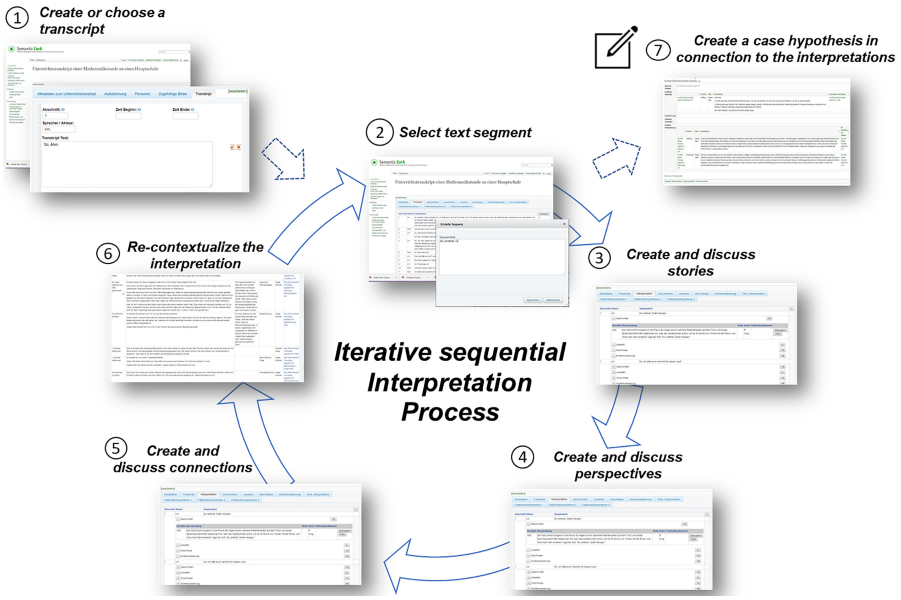

Fig. 1. Workflow of multiple-layered interpretational acts in research environment.

The research environment provides the empirical data (interaction protocol), including single numbered sequences, their actors and their statements (Fig. 1, steps 1 and 2). These protocols allow for a stepwise analysis of the text. Single menu tabs mark the four different interpretational steps in objective hermeneutics. This design offers a new level of explication for the stepwise iterative interpretational acts and facilitates the methodological guidance. The methodological objectives can be more profoundly materialised because the digital environment enables direct interactions with the protocol and the interpretational steps. Paper-based teaching material like methodology articles needs to describe the concrete research interaction and should be at hand, read, and transferred to the concrete situation. With its structured menu that adapts acts in objective hermeneutics, the digital environment can guide the students through the concrete interpretational acts. Thus, students are enabled to have the method at hand at each point of the analysis because possible interactions and the process of the stepwise interpretational acts are visualised within the environment. The interpretational acts are transparently articulated, which enables a guidance for research-based learning. While this methodological guidance equips the students with a kind of independence, the lecturer can use the research environment as a point of reference for methodological practice. Figure 2 shows the interface of the environment with the text segments and the interpretational acts.

In the research environment, the central role of collaboration is realized through the possibility to create parallel variants of alternative interpretations, discussions, and notes at each interpretational step. In face-to-face interpretations, the objective

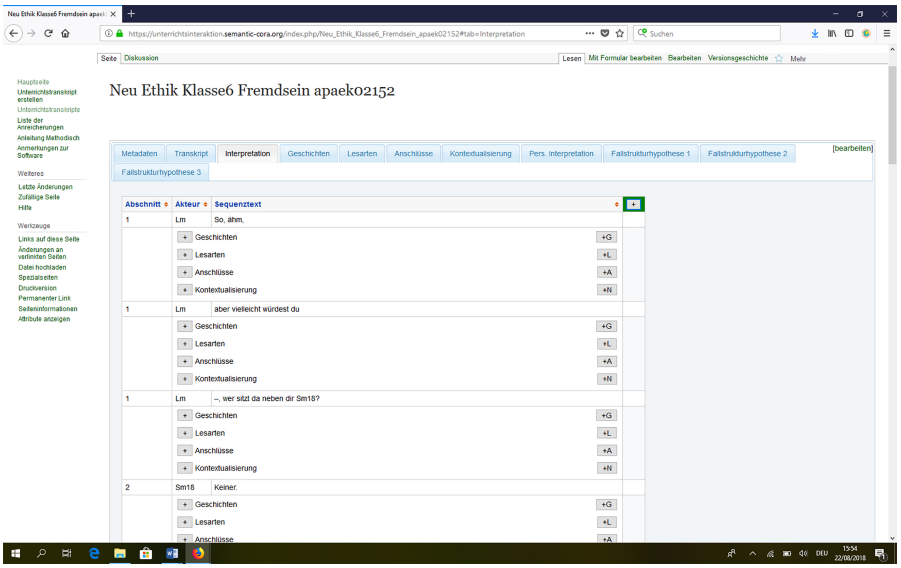

Fig. 2. Segmented texts with interpretational acts of objective hermeneutics in the research environment.

hermeneutics discourse is verbally materialized in a fluid way and the alternative interpretations need to be remembered or documented individually. The research environment keeps records of the multiple interpretations and visualise them for all participants. This offers students a more explicit frame for interpretation and learning. Each interpretational act is pre-structured in the environment and is visible for each group member. Figure 3 demonstrates a selected segment of the protocol at the top ("Was ist so schwer daran"), followed by variants of interpretations for stories and discussions. For the final interpretational act, the interface offers the possibility to create a hypothesis in explicit relation to the relevant interpretations.

Given a digital platform as a research environment, it is possible to work together at different points in time and from different places. This spatially distributed and time-delayed collaboration is a great capacity for students in research-based learning settings as it allows for organizing their work more autonomously. Spatially distributed students do not need to travel to face-to-face meetings, which makes it easier to form groups and facilitates a more individual timing of analysis. The face-to-face analysis requires meetings that may last for several hours, which is an organisational challenge for a group of students with different schedules. As the digital environment collects and stores all collaborative analysis processes of the students, lecturers are able to access and assess them.

From the lecturer's perspective, the capability to retrace the analysis process enables a more in-depth guidance of the concrete interactions of the students (compare Reinmann 2016: 234). For example, the lecturer can identify the lack of interpretational acts or the violation of principles. Or they can retrace the interpretational acts

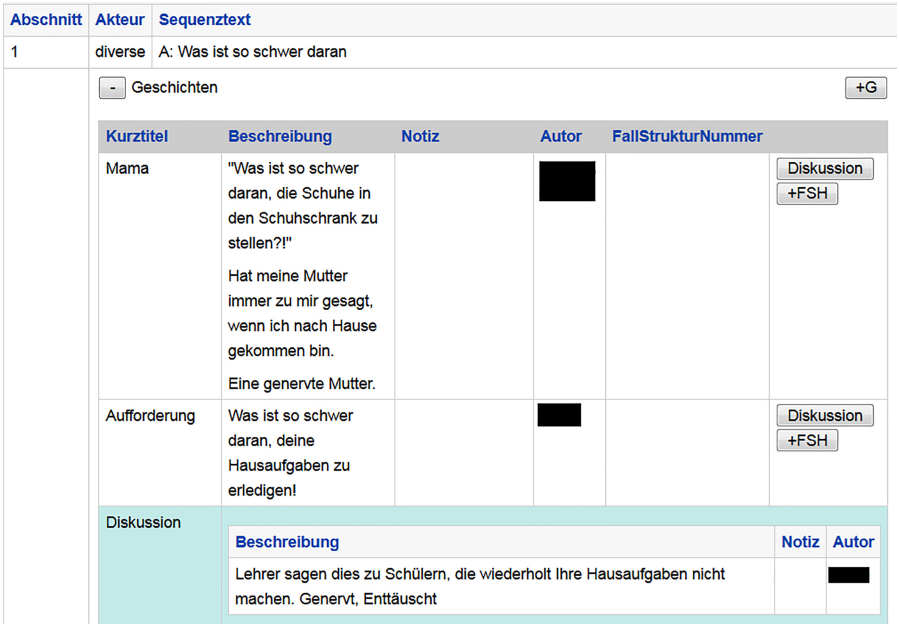

Fig. 3. Selected segment with different forms of collaborative interpretation.

for an in-depth diagnosis and give personalized feedback. Feedback can be given directly in the environment or later in face-to-face meetings.

In qualitative research, replication is a minor aspect of open science, but the transparency of the research process is emphasized for the validation and for the plausibility of findings (see Section 2.1). Usage of digital technology offers a new capacity concerning transparency of the research process. In the environment, each explicit articulation is documented and each interpretational act is explicitly related to the empirical data. Hence, the environment allows for retracing the whole analysis process from the segmentation of a relevant text unit to the multiple interpretations and their discussions to the case hypothesis. Other researchers can use this data to reconstruct the research and validate the plausibility, and might as well use it for the reflection and teaching of the research itself. Using and re-using analysis data offers a great capacity for learning and teaching research and methods.

With regard to pedagogical aspects, students are able to explicitly focus and reflect on their own research and work as they are able to browse backwards and forwards across all analysis steps. While in verbal face-to-face communication, references to previous interpretational acts depend on the individual memory capacities and note-taking techniques, the digital environment re-configures this fluid situation. The materialization of the various interpretational acts, discussion and notes in written form creates an explicit common ground, which is continuously retraceable and reflectable.

Table 1
Added values of open analysis in learning and teaching

	Student	Lecturer
Methodological transparency	– More explicit methodological guidance at hand – Greater independency through low-threshold research capacities	– Point of reference for methodological practice
Digital collaboration	– More explicit collaborative, multi-perspective analysis – Greater autonomy for organizing research (time/space) – Involvement of external participants in digital environment	– Transparency of students' collaborative analysis process – (Blended) feedback
Digital retracing	– Explicitness of whole analysis process for ongoing validation and reflection	– In-depth guidance of whole analysis process with validation and consensus building

To summarize our discussion, we see open science in qualitative research as a controversial but emergent phenomenon and argue for the need to concretize boundaries and capacities of openness, especially in learning and teaching. Table 1 summarizes the added values of open analysis in learning and teaching of qualitative research like guiding of students in learning for research (compare Reinmann 2016).

5. Study of open analysis in learning and teaching

5.1. Settings

So far, the digital environment was used in two seminars in educational science studies at Goethe University Frankfurt and Europe University Flensburg in Germany, where students worked on a small research task based on objective hermeneutics. The lectures followed a research-based learning approach with the aim to develop a scientific research habitus (Helsper, 2014) with research capacities, personality, and reflexive action. Reinmanns (2016) conceptualisation of research-based learning describes the pedagogical setting of the seminar:

> First, students learned about research while lecturers taught research theories and more specifically the method of objective hermeneutics. Second, students learned for research while applying research methods in their classes. Third, students learned through research while conducting a research question and objective hermeneutics analysis in the digital environment. Hereby, students formed groups and worked on their projects for several weeks. Each group created a research paper as an outcome and discussed their interpretations in the seminars. The students were free to decide whether they use the digital environment or approach their task in the traditional offline way, without any constraint from the lecturer.

While our research is explorative, we started a first evaluation of the environment in one seminar and created an online questionnaire (Table 2). The questionnaire focused on the use of the research environment, whereby half of the questions offered an option for comments.

5.2. Outcomes and discussion

Two groups of three students each used the research environment and gave feedback (Table 2). The six students described themselves as passive users of wikis, who had never edited a wiki article at all (Q2) but search from often to rarely in a wiki like environment (Q1). Despite this limited experience with wiki technologies, the students required little time for training and familiarization with the digital environment (Q3) and characterized their orientation after the introduction (Q4) as being "good" (2 students) and "partly good, partly bad" (4 students).

All six students were able to do their tasks (Q5) during two to six hours (Q6). Three out of six students described the research environment as being helpful, two as partly helpful and one as rather not helpful (Q7). This impression of a support of the students learning practices is accentuated for the responses to the question whether the students would recommend usage of the research environment to other students (Q8): Four answered "partly yes", two have been undecided.

While the sample size of the questionnaire is quite small, the students' comments offer some indications for discussion and contextualisation. Two students explicated in their comments the support through the stepwise and transparent and structured methodological guidance. One of these students mentioned: "The structure of the research environment was helpful. This made the stepwise procedure easier". A further comment underlines the guidance by hinting directly at the support for people without experience of the method.

The students' comments in the questionnaire also highlighted the spatially distributed and time-delayed collaboration. One student emphasized this capacity for collaboration: "However, to make an interpretation with several people who need to travel a long distance or do not see each other for a long time, it is outstandingly well suited".

At the same time, this flexibility of time and space also challenges the individual organization of the collaborative analysis. "It could happen that you lose the 'task' and you do not return to the PC/laptop" was a student's answer. One other student commented on the pedagogical setting and described the usefulness of the research environment after conducting the face-to-face interpretation. This indicates that the research environment should not replace face-to-face analysis in learning and teaching, but rather act as a complementary element.

The digital environment enables a potential for collaboration and collaborative interpretation which is time- and place-independent. However, there is a main epistemological boundary: The face-to-face verbal communication is faster, involves more

Table 2
Feedback on the use of the research environment

Questions	Answers				
Q1: How often do you search for information in a wiki (e.g. Wikipedia)?	I very often search for information in a Wiki.	I often search for information in a Wiki.	I sometimes search for information in a Wiki.	I rarely search for information in a Wiki.	I never search for information in a Wiki.
	0	2	2	2	0
Q2: How often do you edit a wiki (e.g. Wikipedia)?	I very often do edits in a Wiki.	I often do edits in a Wiki.	I sometimes do edits in a Wiki.	I rarely do edits in a Wiki.	I never do edits in a Wiki.
	0	0	0	0	6
Q3: How long did you need to familiarize yourself with the research environment?	Two hours or less.	Two to four hours.	Four to six hours.	Six to eight hours.	More than eight hours.
	5	1	0	0	0
Q4: How did you get along with the research environment after the introduction? (free comment possible)	Very good.	Good.	Partly good, partly bad.	Bad.	Not at all.
	0	2	4	0	0
Q5: Were you able to complete the given task with the research environment?	Yes, I was able to complete the given task.	Yes, the research environment was a start, but we also had to meet personally (please specify).	No, the research environment did not help us.		
	5	1	0		
Q6: How long did you need to complete the task with the research environment? (free comment, categorized)	Two hours or less.	Two to four hours.	Four to six hours.	Six to eight hours.	More than eight hours.
	0	4	2	0	0
Q7: Did the research environment help you in the process of interpretation? (free comment possible)	The research environmentwas very helpful.	The research environment was helpful.	The research environmentwas somewhat helpful.	The research environment was not very helpful.	The research environment was not at all helpful.
	0	3	2	1	0
Q8: Would you recommend other students to use the research environment? (free comment possible)	Yes, very much.	Yes, partly.	Undecided.	Rather not.	No.
	0	4	2	0	0

embodiment (e.g. gestures, spatial referencing), and creates a discursive flow of interpretation more easily. While this restriction was articulated by the educational scientists in the design process of the research environment, the students did not mention this as a problem.

6. Conclusion and outlook

Open science encompasses a large number of potential transformations of scholarly practices, whereby the scope of open science practices are in flux. Research communities have started to adjust the capacities of openness to their research practices and to create common principles. The alignment of the open science vision to pedagogical settings offers new pedagogical approaches with pedagogical capacities and boundaries for learning and teaching research. In this article, we focused on open analysis in qualitative research while offering a digital space of exploration, where students are productive, discover, and are mainly guided through research (Reinmann, 2016). While we see added values for learning and teaching of open analysis like better guidance, transparency and support, research needs to be done concerning the full potentials of open analysis with regard to collaborative interpretation processes, the real-time retracing of process and the implementation of open concepts in research-based learning settings.

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