International Society of the Learning Sciences

Towards Collaborative Immersive Qualitative Analysis

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Abstract: In this paper, we explore how researchers in Immersive Virtual Reality (IVR) collaboratively analyse how copresent students interactively identify problems based on video data recorded with multiple 2D and 360° cameras. We are working with a double data set – the original recordings and a recording of the analysis performed in IVR. The focus is on how IVR can be used to analyse 360° video data by a distributed team of researchers. We outline a new methodological approach called Collaborative Immersive Qualitative Analysis (CIQA). In contrast to the branch of work in CSCL that focuses on machine analytics, we present a methodology and software that allows researchers to inhabit the captured scene with tools that encourage a more immersive take on interaction analysis. Until now, IVR has primarily been used as a tool for individual cognitive training, but we suggest that IVR can be used to support a collaborative, volumetric research infrastructure.

Introduction

While CSCL is tasked with researching how collaborative learning activities can be supported by technology, it is evident that CSCL is also committed to developing new methods and tools for enhancing analytical processes and outcomes (Jeong et al., 2014). These methods and tools include contingency graphs (Baker et al., 2007), multimodal learning analytics (MMLA) (Martinez-Maldonado et al., 2013) and Mondrian transcripts (Shapiro et al., 2017). MMLA has been one of the central developments in CSCL in recent years, advancing the ways computers can support the analysis of collaborative actions in online and physical settings. Recently, Wise et al. (2021) suggested to make Leaning Analytics (LA) more relevant for practitioners by focusing on Collaborative Learning Analytics (CLA). This marks an interest in generating outputs from computer-supported analysis that are relevant and understandable not only for the researchers involved, but also for practitioners who are not familiar with algorithmic outputs. On the continuum between qualitative and quantitative research in CSCL, the majority of tools and methodologies developed for analysing collaboration is more oriented overall towards quantitative research (Jeong et al., 2014). However, new ways of representing qualitative research, for example under the auspices of multimodal transcripts, have also surfaced CSCL (Davidsen & Ryberg, 2017). Nevertheless, qualitative studies in CSCL, up to now, have been less focused on developing new computer-supported methods and tools. But with 360° video and Head Mounted Displays (HMD) for IVR, new opportunities emerge for qualitative analysis (McIlvenny, 2020a, 2020b; McIlvenny & Davidsen, 2017) and, more specifically, for a revitalisation of Interaction Analysis (Jordan & Henderson, 1995) in CSCL. To show how IVR can support researchers in analysing collaborative learning activities, we present, analyse and discuss how two researchers using IVR worked together on a proto-analysis of problem identification by architecture students.

The aim of this paper is to introduce Collaborative Immersive Qualitative Analysis (CIQA) as a new methodological approach that allows researchers and practitioners to inhabit and analyse a 360° video together. The origin of CIQA is closely connected to the development of software for analysing collaborative activities captured using 360° video in an IVR environment. Recently, IVR has been highlighted as a new arena for collaborative learning (Enyedy & Yoon, 2021), and the potential of IVR for immersive training and learning is well documented (Abich et al., 2021), but we argue that IVR also offers novel ways of researching collaborative learning based on the foundations and practices developed in Interaction Analysis (Jordan & Henderson, 1995).

In the paper, we present a tool called *CAVA360VR* (Collaborate, Annotate, Visualise and Analyse 360° video in Virtual Reality) that supports the methodology of CIQA. We also introduce how we use it to analyse how synchronous collaboration can take place between peers in IVR. Using *CAVA360VR*, researchers and practitioners are immersed in a scene recorded with a 360° camera, which they can analyse together using different 3D tools. This is of special interest for CSCL as a methodological practice because video recordings are often used to analyse collaborative activities. Unfortunately, in most cases the video data is transformed into a talk-centred transcript that poorly represents the spatial event. In addition, we also demonstrate that IVR can be used for fostering social activities in a CSCL setting, e.g. how meaning-making is interactionally accomplished. We strongly believe that our CIQA methodology can support the design of IVR-based CSCL activities in the future.

Collaborative immersive qualitative analysis (CIQA)

CIQA is rooted in Interaction Analysis (Jordan & Henderson, 1995) and ethnomethodological conversation analysis (EMCA) (Goodwin, 2017). Generally CIQA is preoccupied with the local practices of meaning making in collaborative activities, and it treats the participants' sociotechnical interaction as a first analysis of the event. Researchers working with interaction analysis and EMCA are often using video cameras to record a practice that are then transformed into transcripts. Often Interaction Analysis researchers are meeting up for so-called 'data sessions' to analyse the data with others (see also McIlvenny 2020b for tools to enhance data sessions). In CIQA, we also record a collaborative setting using one or more 360° cameras, additional 2D cameras and dedicated (spatial) microphones. The video data is also transcribed for close inspection; however, with CIQA, researchers gather in IVR to inhabit the recorded data together. CIQA researchers step immersively into the data 'staged' using *CAVA360VR*. The 360° video recording becomes a shared virtual canvas for the researchers so they can inhabit the data. As we show in the analysis, *CAVA360VR* supports researchers in inhabiting the 360° video with different 3D tools to enhance qualitative analysis together.

Introducing *CAVA360VR*

CAVA360VR is a prototype Unity-based Windows application that enables researchers to collaboratively annotate, visualise and analyse 360° video in VR. Currently, *CAVA360VR* supports 20 simultaneous users via a multi-user networking platform. *CAVA360VR* is developed by the BigSoftVideo team at Aalborg University. In *CAVA360VR*, remote researchers can share, view and interact with a 360° video together, draw on the 360° video, use a 'mirror-cam' to see what is behind you, use a 3D laser pointer to guide others' attention, import a 2D image, view a prepared transcript, and view a synced 2D video with the 360° video. Furthermore, participants can talk to each other, and the audio is spatialized in IVR. In *CAVA360VR*, each participant is assigned a 3D avatar (and virtual hands) that follows the orientation of the HMD (and controllers) of the individual. *CAVA360VR* is not only available in VR, but can also run as a standard Windows desktop application with a subset of tools, which allows a larger, mixed group to participate in the analysis of the recorded data.

In Figure 1 (see online archive: doi.org/10.5281/zenodo.6365444), there are two screenshots taken from the desktop video recordings of a virtual *CAVA360VR* session with two researchers. On the top of the image, the viewport from researcher 1's (R1) HMD is shown. The blue trace on the screen (middle of the image near BS) is showing where R1's right controller is pointing. On the bottom one can see R2's viewport in their HMD of the same scene, where R2 is pointing and a trace of what R1 is pointing at (e.g. BS). R2 is viewing a group of additional tools, e.g. a timeline and a transcript window. Each participant can reposition all the additional tools as they see fit without conflicting with the other users' preferences. This provides a flexible and personalized, yet shared, IVR toolkit for analysing video together with fellow researchers.

The original data – Arch-1

To showcase the methodology of CIQA and *CAVA360VR* as a tool for analysing collaborative activities we present a case study, in which two researchers collaboratively analyse how a group of architecture students work together. The data collected with the architecture students is referred to as the Arch1-data, and the data showing how the researchers used *CAVA360VR* is referred to as the CAVA-data. In a nutshell, we are working with a double dataset and the purpose of the analysis in this paper is to show how the researchers are analysing the original data using *CAVA360VR*. Briefly, in the Arch-1 data we see a group of six architecture students working in a workshop environment in pairs. Each of the pairs are working on parts of an overall design, which they have to present at a 'crit' seminar with their teachers and other student groups. As shown in Figure 2 (see online archive), the students (initials in blue squares) are positioned in different locations in the room, and the dotted lines are showing how they move around. The red squares indicate the position and type of camera in the recording. In Figure 3 (see online archive), we have provided a comic transcript to represent the groupwork situation that the researchers analyse using *CAVA360VR*. In short, EM and DA are experiencing troubles with the material design they are working on, which will impact the others. UN stands opposite to EM and DA. At the other end of the room, KT is cuts out foam pieces. Then, UN says "uh oh:" while looking at EM and DA. KT walks into the middle of the room, looking in the direction of EM and DA, and says, "does it irritate you (.) emma". Both UN and BS look in the direction of KT. Then KT walks up to UN. They are now both positioned directly opposite EM and DA in a larger cluster to troubleshoot the problem. With this short intro to the Arch-1 data, we present and analyse the collaborative analysis performed by R1 and R2 in the CAVA-data.

Performing an immersive collaborative qualitative analysis

The collaborative immersive analysis performed by the two researchers is building on earlier analytical steps performed by the individual researchers in IVR. Besides the 360° video data, the researchers also have a transcript

and an additional 2D video available in IVR. The session in *CAVA360VR* is the first attempt to analyse the 360° video of the architecture students in a collaborative IVR data session. This session is 21 minutes long and is part of a collection of data using *CAVA360VR* for CIQA. We will look at two related themes in the analysis: (1) the interactive establishment of a shared immersive space for analysing the 360° recording, and (2) the use of the tools in *CAVA360VR* for highlighting and accounting for analytical claims. To show how R1 and R2 are analysing the Arch-1 data, we transcribed the CAVA-data using the Mondadaian transcription system (Mondada, 2018) to obtain a complex transcription of the interaction. For the purposes of this paper, we have produced comic transcripts (anonymised and numbered) that are more digestible. In the Figures below, each comic panel consist of two images taken from a monoscopic 2D recording of R1 and R2's viewports. Each panel shows the direction that R1 (top image) and R2 (bottom image) were looking in IVR.

In the first extract (Figure 4 – see online archive), R2 is presenting an initial analysis of the data to R1. R2 is trying to show how KT is positioning herself in the room and then asking a question before she walks up to UN. As both R1 and R2 are immersed inside a specific camera/position in the room, they can only view the 360° video spherically from that camera position, yet they and the tools inhabit 3D space. R2 brings up a shared view of a synced secondary 2D camera view to build up the analysis. Both R1 and R2 need to reposition the additional video window that appears in the scene (see panel 2 in Figure 4) to smoothly contextualise and make use of the view. R2 is actively searching for a solution in (panel 3), while R1 is repositioning the transcript window and opening up the 2D video window. Then, R2 picks up and moves his 2D video window, and states "we can look from it (.) HAHAHAH" (panel 4). R2's joy of finding out about the availability of the additional camera view is clearly hearable. Afterwards, both R1 and R2 are rearranging the 2D video window to create the best possible spatial scenography for the ongoing analysis. This analytical practice is not possible with desktop video software. In this CIQA environment, it is possible to be surprised by what it is possible to 'see' virtually after all.

In the second extract (Figure 5 – see online archive), R1 is using the virtual drawing tool to highlight, guide and establish shared awareness with R2. For the entire session, R1 and R2 have been trying to establish how talk, body movement and gaze are laminated by the students in Arch-1 to identify the problem, but only at the end of the session is R1 drawing on the 360° video. By drawing, the analytical points are given a material presence for both researchers in *CAVA360VR*. First, R1 says: "there are a number (.) a number of reorientations". He continues: "from her to her" (see panel 1 in Figure 5) and starts to draw on the video to indicate indexically where each of the students are positioned. R2 is not able to see the first circle made by R1 (panel 1), but the second circle on top of KT is within the field of vision of R2. R2 then reorients towards the area of the immersive space where R1 is making drawings to account for the analysis. Consequently, R2 tracks the way R1 is making drawings on the video of the participants, also when R1 turns 180° while drawing a diagonal line from KT to EM/DA (panel 6). It shows that the tools for highlighting and making a material presence in the immersive scene are important for CIQA. R1 could simply have pointed at the different students to show the re-orientations, but, with the drawings, the emerging analysis is materialized and collaborative.

Discussion and conclusion

In CSCL, video has always been used to study collaborative learning activities, and recently computer-supported analytics have made it possible to work with big data sets. A CIQA methodology, presents an alternative, yet complementary, approach in CSCL. While LA and MMLA can generate visual graphics and statistics of a collaborative activity, the situation in which the collaborative activity in playing out is transformed into a distant proxy of the event. Instead, we want to return to and extend the pioneering work in CSCL that focuses on practices of meaning making in relation to collaborative research practices. With CIQA, researchers and practitioners can immersively inhabit a CSCL setting together, and they are given the freedom to position the tools and data sources as the users see fit to create a balanced virtual environment that is personalized, yet shared. This is a poly-centric version of Interaction Analysis because each researcher can flexibly create a volumetric and spatial environment for analysing the 360° video together. In both of the extracts, we see how the researchers are able to use the interactive features of *CAVA360VR* to build an analysis together. It is clear that the material presence of the other user (as an avatar) and the tools used are important for establishing shared attention to the analysis of the data. Simply passively viewing a 360° video together in an IVR environment (or on a flat screen) is not extending IA. For CIQA, it is crucial to develop tools that create a sense of shared immersion in the recorded CSCL scene, and also to support establishing a shared material presence of the analysis through public and transparent manifestations of analytical claims directly in the data. The fact that each researcher in *CAVA360VR* is present in the virtual environment with an avatar head, a set of virtual hands and a visual trace following the movement of the controller is providing just enough resources to create a sense of collaborative virtual presence.

For CIQA, it is important to give researchers a possibility to reposition camera views and other data sources as they see fit. This is in stark contrast to the frozen composite videos traditionally used in interaction analytical studies in CSCL. CIQA is about composing in situ the video data archive to enhance the analytical space for the researchers. Instead of speculating about what we can see from another camera perspective, we can add that camera view to the shared immersive environment (provided the event was recorded from multiple perspectives). We invite researchers in CSCL to establish a complementary approach to computer-supported analytics, e.g. MMLA. With CIQA, we move beyond 'visualized facts' (Kitchin et al., 2015) and focus, instead, on how researchers collaboratively can inhabit the data and analyse phenomena immersively.

There is a need for researchers in CSCL to develop and design IVR environments that support collaborative activities. To further develop CIQA, we need to provide new tools that can support a richer sense of immersion in qualitative data. For example, users should be able to jump between multiple 2D and 360° videos, as well as (spatial) audio sources, in the scene. In addition, a Volumetric Capture and Replay system that can capture and re-activate immersively the actions of multiple users in *CAVA360VR* would afford a richer, shareable, revisitable trace of proto-analytical practices. It would also provide a new medium to document and publish the empirical analytical work itself that undergirds a traditional publication.

Acknowledgment

Without the brilliant work of BigSoftVideo's software developers Nicklas Haagh Christensen and Artúr Barnabás Kovács, we would still be passively viewing a boring flat version of the event. We also want to thank the DIGHUMLAB project and the Faculty of Social Science and Humanities at AAU for their support.

References

Abich, J., Parker, J., Murphy, J. S., & Eudy, M. (2021). A review of the evidence for training effectiveness with virtual reality technology. *Virtual Reality*.

Baker, M., Andriessen, J., Lund, K., van Amelsvoort, M., & Quignard, M. (2007). Rainbow: A framework for analysing computer-mediated pedagogical debates. *International Journal of Computer-Supported Collaborative Learning*, *2*(2), 315–357.

Davidsen, J., & Ryberg, T. (2017). "This is the size of one meter": Children's bodily-material collaboration. *International Journal of Computer-Supported Collaborative Learning*, *12*(1), 65–90.

Enyedy, N., & Yoon, S. (2021). Immersive environments: Learning in augmented + virtual reality. In U. Cress, C. Rosé, A. F. Wise, & J. Oshima (Eds.), *International Handbook of Computer-Supported Collaborative Learning* (pp. 389–405). Springer International Publishing.

Goodwin, C. (2017). *Co-operative action*. Cambridge University Press.

Jeong, H., Hmelo-Silver, C. E., & Yu, Y. (2014). An examination of CSCL methodological practices and the influence of theoretical frameworks 2005–2009. *International Journal of Computer-Supported Collaborative Learning*, *9*(3), 305–334.

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *The Journal of the Learning Sciences*, *4*(1), 39–103.

Kitchin, R., Lauriault, T. P., & McArdle, G. (2015). Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science*, *2*(1), 6–28.

Martinez-Maldonado, R., Dimitriadis, Y., Martinez-Monés, A., Kay, J., & Yacef, K. (2013). Capturing and analyzing verbal and physical collaborative learning interactions at an enriched interactive tabletop. *International Journal of Computer-Supported Collaborative Learning*, *8*(4), 455–485.

McIlvenny, P. (2020a). The future of 'video' in video-based qualitative research is not 'dumb' flat pixels! Exploring volumetric performance capture and immersive performative replay. *Qualitative Research*, *20*(6), 800-818

McIlvenny, P. (2020b). New technology and tools to enhance collaborative video analysis in live 'data sessions. *QuiViRR: Qualitative Video Research Reports*, *1*, a0001–a0001.

McIlvenny, P., & Davidsen, J. (2017). A Big Video manifesto: Re-sensing video and audio. *Nordicom Information*, *39*(2), 15–21.

Mondada, L. (2018). Multiple temporalities of language and body in interaction: Challenges for transcribing multimodality. *Research on Language and Social Interaction*, *51*(1), 85–106.

Shapiro, B. R., Hall, R. P., & Owens, D. A. (2017). Developing & using interaction geography in a museum. *International Journal of Computer-Supported Collaborative Learning*, *12*(4), 377–399.

Wise, A. F., Knight, S., & Shum, S. B. (2021). Collaborative learning analytics. In U. Cress, C. Rosé, A. F. Wise, & J. Oshima (Eds.), *International Handbook of Computer-Supported Collaborative Learning* (pp. 425–443). Springer International Publishing.