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Chareen Snelson
Boise State University, csnelson@boisestate.edu

Dazhi Yang
Boise State University, dazhiyang@boisestate.edu

Torrence Temple
Boise State University

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Addressing the Challenges of Online Video Analysis in Qualitative Studies: A Worked Example from Computational Thinking Research

Chareen Snelson, Dazhi Yang, and Torrence Temple
Boise State University, USA

In this paper, we share our approach and the process for qualitative analysis of online video data recorded during an after-school robotics program that emphasized computational thinking (CT). Online research strategies may be necessary for various reasons such as when working with a geographically distributed research team, when conducting research with students in an online program, or when resources are inaccessible due to campus closures like those experienced during the COVID-19 pandemic. We followed a three-stage process during qualitative analysis of the videos that included planning and setup, online analysis of videos, and structural coding of memos to explore patterns across the data. Analysis was conducted with a combination of technologies including Google Drive for collaborative coding online and NVivo to collate and summarize findings. The methods and process we describe are readily applicable to other research studies that include video as part of the data set.

Keywords: online video, qualitative video analysis, computational thinking

Introduction

Video in qualitative research is valuable as an audiovisual record of everyday events, such as classroom interactions, that can be closely reviewed, replayed, and analyzed repeatedly during an investigation. How video is used in qualitative research depends on factors such as the goals of the study, experience of the research team, and how technologies for recording, file management, and data analysis are selected and used (Derry et al., 2010; Fitzgerald et al., 2013; Heath et al., 2010). In some studies, it may become necessary to perform some or all the research activities online such as when research personnel are geographically distributed, when conducting research with students enrolled in online programs, or when face-to-face research is not feasible for some reason. A recent example is the COVID-19 pandemic, which drove heightened interest in how to collect data online using videoconferencing applications when it was more difficult to conduct research in person (Gray et al., 2020; Lobe et al., 2020). Qualitative analysis of video files in an online space can be challenging given that technologies designed for qualitative analysis, such as Computer Assisted Qualitative Data Analysis Software (CAQDAS), vary in functionality and may have limited options for analysis of video files stored online (Silver & Lewins, 2014; Silver & Patashnick, 2011). The aim of this methodological paper is to share how we conducted video analysis online and what was learned through our research experience and to promote discussion about strategies for research involving online video data.

Video in Qualitative Educational Research

Video has an established role in qualitative and social research practice as a medium through which an audiovisual record of everyday events, such as classroom interactions, can be preserved and made available for close scrutiny, replay, and repeated analysis during an investigation (Heath et al., 2010). In educational research, video has been conceptualized as offering a window through which classroom interactions can be viewed, a lens to focus on certain aspects of classroom activity, or a mirror for reflecting on teaching, learning, or research practice (Clarke & Chan, 2019). The benefits of preserving those fleeting aspects of classroom practice in video for research purposes are compelling, but also challenging due to existing technologies and how they support or constrain our work, how much those technologies cost, and how difficult they are to use. Over the years, film and video technologies have evolved from bulky, complicated, and expensive systems to more affordable digital technologies that are convenient to use in research endeavors. Erickson's (2011) brief history of video in social research offers a concise overview spanning several decades and illustrates how technologies evolved and were integrated in research practice. Many of the early technologies were cumbersome and weighty. For example, in a 1967 research study, Erickson used a 25-pound camera that required "reels of tape that were an inch thick and about 16 inches in diameter" (p. 181). Now, smartphones, equipped with high-definition video cameras, are increasingly common in society (Silver, 2019). The widespread availability of affordable portable digital video technologies is advantageous for researchers who need quick and easy access to video recording technologies.

The growing ubiquity of digital video recording technologies is helpful, but equipment alone is not the only factor to consider when integrating a video component in research. Researchers are faced with a variety of practical and methodological decisions when recording video, managing video files, and analyzing video data (Derry et al., 2010). Heath et al. (2010) described some of the challenges associated with acquiring video data that include gaining access to the location where recording will occur, obtaining necessary permissions, deciding how much video to record, identifying camera positioning and framing, and determining the influence of the camera on participants. Similarly, Fitzgerald et al. (2013) drew on experience with a video ethnography of science teaching practices to unpack how issues with sampling (e.g., camera placement and what to capture on video), authenticity (e.g., influence of the camera on participant interactions), and ethics (e.g., confidentiality of recorded participants) impact the collection of video data. Luff and Heath (2012) delved into camera placement even further by examining several methods for camera positioning such as the roving camera that moves around the scene, use of stationary fixed cameras placed in strategic positions to capture different angles of the scene, use of wide-angle lenses to capture more of the scene, mid-shot recording to focus on small groups, and multi-camera approaches to record the scene from different perspectives. Each approach has benefits and disadvantages pertaining to logistics or feasibility, intrusiveness in the situation being recorded, or how the recording is framed by the camera position to reveal or conceal naturally occurring events and interactions occurring.

Video data collection in online settings is inherently different when participants are physically separated. It is no longer necessary to carry equipment into a physical classroom and determine where to position equipment or what camera angles to use. However, other tools, such as videoconferencing systems, are needed to facilitate the process of acquiring video data or observing online classroom interactions in real time. For example, Berry (2017) used Adobe Connect videoconferencing software to record video of synchronous online class meetings during a qualitative case study of community building in online doctoral education. Saltz and Heckman (2020) used video breakout rooms in their case study of an instructional strategy, called a Structured Paired Activity, that put online students into two-member teams while completing programming activities. Observations were conducted within the online video breakout rooms to document naturally occurring behaviors and develop new insights about team roles and processes. Ho (2019) applied a novel approach for acquiring video as part of a study of online language learning. Participants were asked to install Camtasia screen recording software and record video while completing an online lesson. Participants verbalized their experiences in a think-aloud approach while recording their computer screen and webcam. The video files were uploaded by the participants to a secure, password-protected Dropbox drive so that they could be accessed by the researcher for analysis. This approach offers participants more control over the video they share, but also requires technical support for software installation or transfer of large data files.

Qualitative Analysis of Video

Strategies for analysis of videos in qualitative research include indexing the videos to develop a content log with time codes and descriptions of video content, segmenting videos into events or clips relevant to the research questions, transcribing audio and visual content contained in the videos, and conducting cycles of review to code, compare, and engage in fine-grained analysis (Derry et al., 2010; Heath et al., 2010; Knoblauch & Tuma, 2020). These strategies require the use of technology to facilitate the process of working with digital video files. Researchers might choose software specifically designed for audiovisual analysis or use CAQDAS programs that support analysis of multiple types of data including video (Estrada & Koolen, 2018). However, software tools for video analysis differ in their functionality and suitability for handling the research tasks associated with audiovisual data (Silver & Patashnick, 2011). When selecting technologies for qualitative video analysis researchers will find it prudent to consider factors such as functionality, cost, ease of use and whether the chosen tools will do the job required to complete analysis. The situation is complicated when working with online videos as a data source since CAQDAS tools often have limited support for online data analysis (Silver & Bulloch, 2017). Desktop CAQDAS software opens linked video files saved on the same computer, rather than online files, although there are some limited exceptions. NVivo (QSR International, 2020) has a web browser extension called NCapture that can be used to sample online social media data including YouTube videos and comments. The videos remain on YouTube and display within the NVivo software. Analysis (i.e., coding) can be done directly on the media timeline or on a synchronized transcript. At the time of this writing, this functionality only works on computers running the Windows operating system and is limited to YouTube videos.

Various problems surface when attempting to work collaboratively online during qualitative analysis of video. Challenges include determining how to work collaboratively online and how to manage video files during the process. With respect to the use of CAQDAS in an online space, Silver and Bulloch (2017) have argued that there are three primary approaches that researchers might choose: (a) work independently and merge copies of the CAQDAS project files, (b) work on multi-user projects on a networked server, or (c) use an online package that works directly through a web browser. Unfortunately, these strategies may not work as effectively when analyzing online video content. Desktop CAQDAS programs with links to video files saved on the same computer become broken when either the project file or the media files are moved. Alternatively, if the videos are saved on a secure online drive, it may not be possible to link directly to them from the desktop software. Downloading or moving the files to another location for analysis may be tedious, time consuming, or possibly restricted due to security concerns and the need to protect research participants recorded in the videos. This is challenging for researchers who need to store large video files online such as when working with a distributed research team who upload files from different sites or when recording videos directly from an online classroom.

A possible solution to the dilemma of online qualitative video analysis is to use a combination of technologies and methodologies that are strategically selected to meet the specific requirements of the research project. The use of a "technology mashup" that includes

Web 2.0 technologies has been suggested as an approach where multiple technologies are used to combine their relative advantages (Davidson et al., 2016, p. 608). Some of the affordances of Web 2.0 technologies that have been identified as potentially valuable in qualitative research include data storage, data organization and management, linking, commenting, annotating, note taking, and collaboration (Davidson & di Gregorio, 2011; Silver & Bulloch, 2017). Unfortunately, there has been a noted lack of discussion in the research literature about the combination of technologies and methodologies to inform analysis of video and other audiovisual data (Silver & Patashnick, 2011; Smith et al. 2016).

An Example from Computational Thinking Research

In this section, we describe a real-world situation where we grappled with the challenges of conducting qualitative analysis of videos that were recorded in a classroom setting and then uploaded to an online drive. The videos were recorded during a case study of CT (computational thinking) practices in an eight-week after-school program for children in fourth through sixth grades. The purpose of the after-school program, where the videos were recorded, was to promote problem solving and CT during the process of building, programming, and testing robots, built from Lego® Mindstorms® kits, that would navigate a simulated Mars terrain and locate water (Yang et al., 2021). Participating students worked in small teams of three under the guidance of two teachers, a former NASA astronaut, three graduate research assistants, and several university faculty members (typically one to three faculty per session). The program was part of a larger National Science Foundation (NSF) funded project created to develop CT and an understanding of Science, Technology, Engineering, and Math (STEM) subjects. Institutional Review Board (IRB) approval was obtained prior to conducting the study on site and additional approval was obtained prior to data analysis when additional research personnel joined the study.

Three groups of students, including six boys and three girls, were recorded during all sixteen sessions of the program over eight weeks with two sessions per week while they completed the activities. Each group was followed by a graduate research assistant who recorded their respective group with a handheld video camera. Video recordings from each session were uploaded to a secure password-protected Google Drive folder where they were organized into folders by week and session. After the program had concluded, the Primary Investigator (PI) for the project recruited another faculty member with expertise in qualitative data analysis and a doctoral candidate with a background in educational technology and science education to assist with analysis of the videos. The three members of this team brought different perspectives and areas of expertise to the analysis phase. The PI had expertise in CT and was involved in all facets of the project. The other two members of this investigation came in later with a fresh perspective and an interest in examining how CT might be identified in "the wild" of a classroom when students were engaged in the process of learning. As experienced educators, we wondered how teachers might identify CT when they saw it happening during a busy and sometimes chaotic project-based program.

The research question guiding the qualitative analysis of video was: How do the students demonstrate CT through problem solving activities guided by project-based learning? CT has been described as a fundamental skill that "involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science" (Wing, 2006, p. 33). CT has been lauded as essential for everyone and beneficial in nearly all disciplines (Bundy, 2007; Wing, 2006, 2008). Yet, consensus has not been fully reached on the core attributes of CT, what it looks like in practice, or how to assess its potential benefits even though efforts have been made toward this goal. One operational definition for CT that emphasizes problem solving processes and dispositions or attitudes was developed in a collaborative effort with the International Society for Technology in Education (ISTE), the Computer Science Teachers Association (CSTA), and leaders from higher education, K-12, and industry sectors (ISTE & CSTA, 2011). Others have defined CT in different ways based on components such as programming processes, abstraction, data processing, symbolic representation, algorithms, conditional logic, problem solving, and computing practice (Grover & Pea, 2013). CT is considered important, but the field remains challenged by its diversity of definitions, models, instructional strategies, and assessments (Cutumisu et al., 2019; Hsu et al., 2018; Shute et al., 2017; Tang et al., 2020).

The task of observing instances of CT in the videos of the after-school program was complicated due to the lack of consensus about what CT looks like in K-12 practice and the paucity of qualitative CT research that integrated video recordings from a naturalistic learning environment. Relevant studies were difficult to find and provided limited information to inform methodological decisions for qualitative video analysis. Only a few studies were identified that shed light on how researchers have approached the task of qualitative research with video data for research involving CT in a K-12 setting (Bowden, 2019; Hadad et al., 2020; Israel et al., 2017; Jordan & McDaniel, 2014; Sullivan et al., 2016). These studies offered some insights into how one might use video as part of a CT study in a naturalistic setting, but often left out details about decisions for data management or analysis. Underreporting of methods is a noted problem for studies involving analysis of qualitative visual data (Smith et al., 2016). Furthermore, the methodological issues of online video have not been clearly addressed leaving us to adapt what is known about qualitative video analysis when conducting research in a collaborative online context.

In the next section of this paper, we share our approach and the process for online qualitative analysis of video data that was recorded in an after-school robotics program for upper elementary school children. The video files were uploaded to a secure online drive where they remained during analysis due to the practicalities of working with a distributed research team working at a distance from each other and requirements stipulated by the local institutional review board.

Three-Stage Analysis of Online Video

We followed a three-stage process during qualitative analysis of the videos from the after-school robotics program that included planning and setup, online analysis of videos, and structural coding of memos to explore patterns across the data.

Planning and Setup

The first step was to plan the analysis procedure and set up the structure for online video analysis. The video data set included 128 individual video files that ranged in duration from 4 seconds to 59 minutes and 50 seconds. The total amount of video was 61 hours, 38 minutes, and 54 seconds. Our university uses the Google suite of tools that comes bundled with email and online applications such as Google Drive for file storage and Google apps for creating online documents, spreadsheets, or presentations. Video files had been uploaded to a secure password-protected Google Drive where they were organized in a nested online file system. This included a folder for each of the eight weeks of the after-school program and subfolders for each session (2 sessions per week). Within each session folder there were additional folders that stored the video files recorded by each of the three graduate research assistants who recorded and uploaded the videos separately. Each research assistant had followed and recorded a different group of students on site so that we were able to observe the work of three teams with three students per team. It was necessary to work with the videos directly in Google

Drive to adhere to IRB requirements for secure data storage and to facilitate work done by a geographically distributed team that had members living in two different states in the USA. In addition, analysis occurred during the COVID-19 pandemic when access to campus was restricted and research endeavors were conducted online, whenever possible.

The university provided licenses for CAQDAS software (i.e., NVivo), but technical challenges prohibited the use of this desktop software for online analysis of video files stored in Google Drive. At the time of analysis, we were unable to locate a CAQDAS program that would do exactly what we needed, which was to view, code, and transcribe video in the software without downloading the video files from the secure online drive. Therefore, we set up an online system using Google Drive apps (e.g., Sheets and Docs) to manage analysis of the video files. We started by creating a matrix in Google Sheets to organize linked data files and track where CT was observed in the videos (Miles et al., 2020). A partial screenshot showing the layout of the matrix in Google Sheets is shown in Figure 1 with identifying information removed.

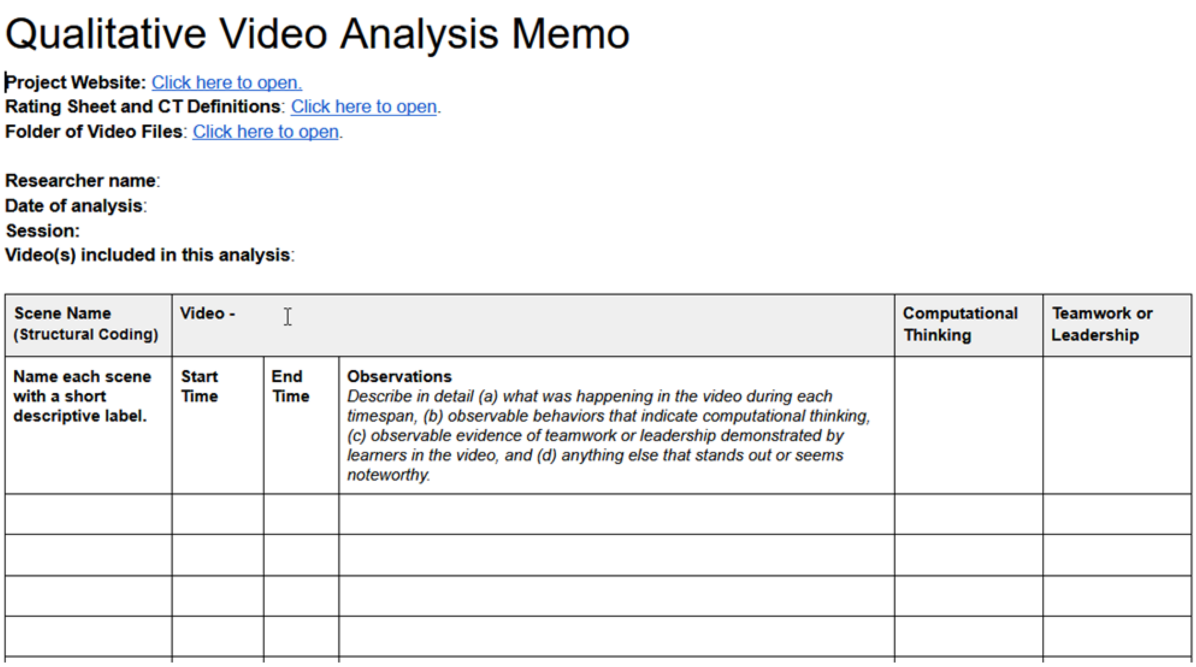
Figure 1
Screenshot of Matrix in Google Sheets

CT Components		Abstractions	Decomposition	Algorithms	Heuristics	Conditional logic	Vocabulary & terminology
Qualitative Memos	**Video Duration**	**Rating Scale for Computational Thinking (Magnitude Coding): 1 = Some Evidence (Teacher led), 2 = Moderate Evidence (Coaching), 3 = Strong Evidence (Independent)**					
W1S1							
Memo	0:40:26	1					1
	0:32:39						
Memo	0:15:40	1				2	
	0:27:14	2					
Memo	0:37:02					1	
	0:06:51					1	
	0:29:15					1	
W1S2							
Memo	-						
	-						
Memo	0:47:30			1	2	1	
	0:23:50				2		
	0:02:15						
Memo	0:59:50						
	0:20:01						
	0:02:46						
W2S1							
Memo	0:43:05	1	2				1
	0:35:00			2		2	
Memo	0:02:56						
	0:36:33	1				1	
	0:36:23				1		
Memo	0:59:50				2,3		1
	0:24:23				3		
W2S2							

The rows of the spreadsheet contained entries for individual video files that were organized by week, session, and source (i.e., Person who recorded the video.). Columns in the spreadsheet were labelled with elemental components of CT that we identified and defined based on descriptions available in the literature (An & Lee, 2014; Grover & Pea, 2013; Wing, 2006; Yadav et al., 2011). The CT components we looked for in the videos included abstraction (reducing complexity), decomposition (breaking problems into components), algorithms (structuring a sequence of steps), automation (using programs to automate a process), heuristics (using problem-solving strategies), conditional logic (applying constructs such as if-then-else), vocabulary and terminology (using CT terminology such as variables and rotation), data collection (gathering data), data structures (looking for patterns), simulation and modelling (testing simulated models), and reporting and communication (documenting and presenting). Definitions of each CT component were added to the matrix spreadsheet for easy access and review during video analysis. A rating scale (1 to 3) was used to apply magnitude coding described later in this paper.

In addition to the matrix spreadsheet, we used Google Docs to establish an online memo system to record observations and generate a content log of the videos (Derry et al., 2010; Heath et al., 2010; Knoblauch & Tuma, 2020). Individual memos were created for each recorded session of the after-school program and included the date of analysis, which video file was reviewed, and who completed the analysis. This was followed by a table where time codes, descriptions of video content, screenshots from the videos, transcripts, and analytic notations could be typed. A screenshot of the memo template is shown in Figure 2. Each memo document was linked from its associated video entry in the matrix spreadsheet so that we could easily access and review the information. We also created a set of online journals that included a project journal to record key events in the research process and individual researcher journals to reflect on our observations while analyzing the videos from each week of the after-school program. Since the work was done online, we were able to review each other's work at any time. We met online through videoconferencing at beginning, midpoint, and end of analysis to discuss the process and what we were observing in the videos.

Figure 2
Memo Template for Video Observations


Qualitative Video Analysis Memo

Project Website: Click here to open.
Rating Sheet and CT Definitions: Click here to open.
Folder of Video Files: Click here to open.

Researcher name:
Date of analysis:
Session:
Video(s) included in this analysis:

Scene Name (Structural Coding)	**Video -**			**Computational Thinking**	**Teamwork or Leadership**
Name each scene with a short descriptive label.	**Start Time**	**End Time**	**Observations** *Describe in detail (a) what was happening in the video during each timespan, (b) observable behaviors that indicate computational thinking, (c) observable evidence of teamwork or leadership demonstrated by learners in the video, and (d) anything else that stands out or seems noteworthy.*		

Online Analysis of Videos

Video analysis was conducted entirely online and involved three key processes: (a) *Observing* – watch the videos to observe behaviors or speech that matched CT component definitions, (b) *Memoing* – write memos and journals to document video content and our interpretation of it, and (c) *Magnitude Coding* – apply a first-cycle qualitative coding process using a magnitude coding approach (Miles et al., 2020; Saldaña, 2016). These processes occurred simultaneously during observation of the video content as described below.

Observing

We watched the videos to observe what was happening in the classroom and how teams of students were interacting during the robotics activities. We looked for observable evidence of CT in student behavior or speech that corresponded to the definitions of CT components we had derived from the literature. For example, we observed students applying a trial-and-error heuristic when developing and testing their robots. They were programming the assembled robots with the Lego® Mindstorms® EV3 software program. We watched them engage in rapid problem-solving cycles where they would modify their programming, download it to the robot, and then test the robot to see what happened. Then, they would quickly go back to the computer, modify the program, and test again. This behavior corresponded to the CT component definition of a heuristic as an experience-based strategy that facilitates problem solving, such as trial-and-error (Yadav et al., 2011). The strategy we used to identify CT based on observable behavior recorded in the videos was similar to Bene's (2014) study where videos of students were analyzed to look for verbal and nonverbal examples of metacognitive thinking such as "exclamations of satisfaction, delight, dismay or frustration and nonverbal expressions such as body language, eye gaze, gestures, pointing, and posture" (p. 6).

Memoing

Observations from the videos were recorded in the online memos (described in the planning and setup section above) where we wrote detailed descriptions of the activities, transcribed conversations, and noted observable evidence of CT. Screenshots of activities, student journals, robotic equipment, laptop computer screens, the classroom setting, and the simulated Mars environment were captured from the videos and included in the memos next to the written observations. The memos were designed to provide a detailed account of visual and audio information observed in the videos consistent with transcription approaches described for audiovisual media (Evers, 2011; Silver & Patashnick, 2011).

Individual classroom activities, such as discussions or programming exercises, were used as natural transition points to segment the videos into meaningful episodes where we could look at how CT was exhibited based on activity type. Time codes where each activity started and ended were also included in the memos together with the activity descriptions so that video segments could be located easily (Knoblauch & Tuma, 2020). The approach of segmenting classroom videos has been suggested as a strategy for identifying episodes that capture phenomena of interest (Derry et al., 2010; Heath et al., 2010). A recent example is found in Krist's (2020) three-year longitudinal study conducted to examine classroom community in the context of middle school science education where the primary data source was video. The video corpus was reduced into meaningful segments "by selecting episodes of science knowledge building activity during each recorded class period" (p. 425). The practice of segmenting video helps to manage a large video data set and parse out the sections that pertain directly to the purpose of the study.

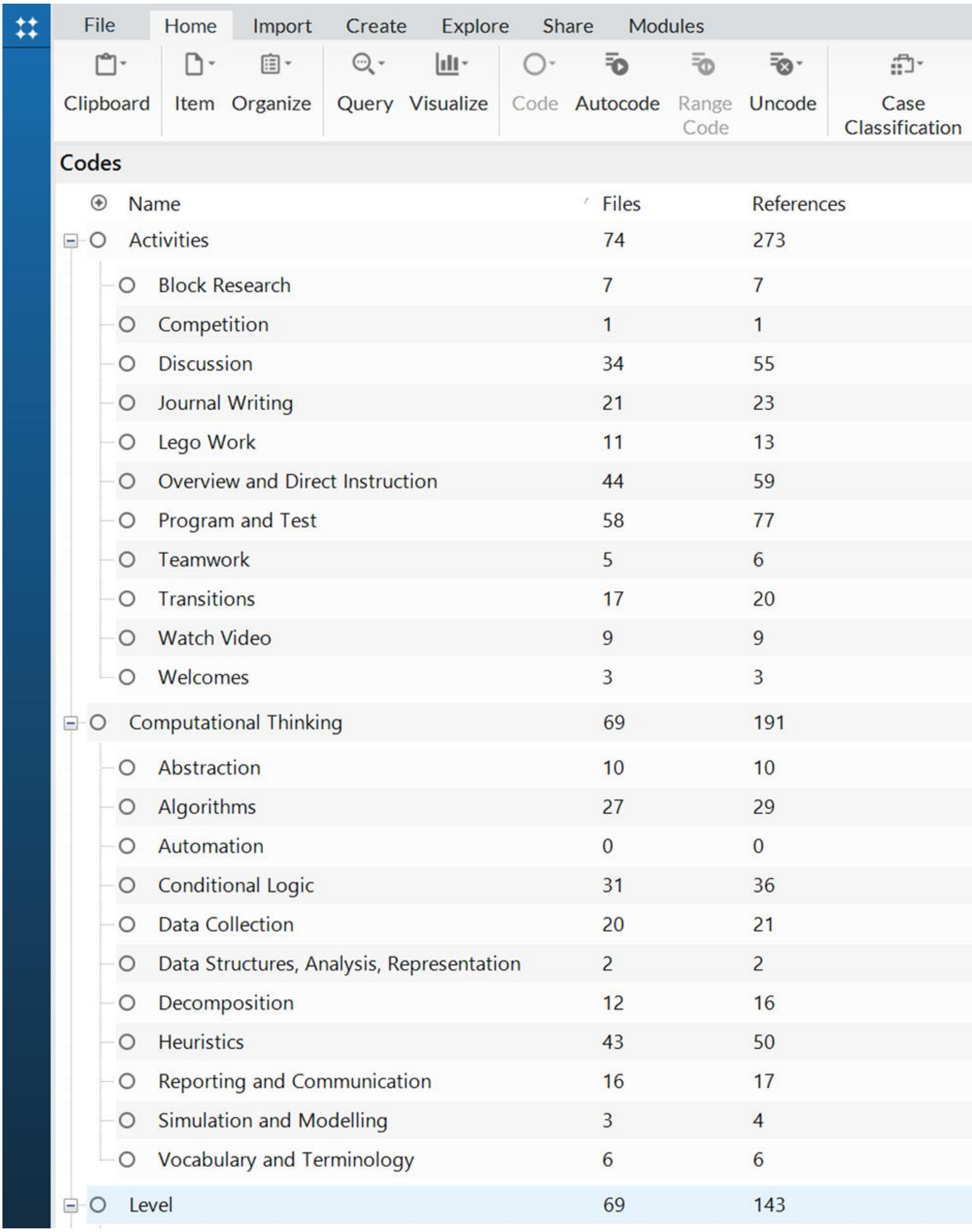
Magnitude Coding

Magnitude coding is a qualitative analysis technique used to indicate “intensity, frequency, direction, presence, or evaluative content” (Miles et al., 2020, p. 71). When an episode of CT was observed in the video it was noted in the memo and marked in the matrix spreadsheet under the appropriate CT column with a rating of 1, 2, or 3 to indicate the level of autonomy exhibited by the students. Level 1 ratings were used for teacher-led activities such as whole-class discussions or watching a video. Level 2 ratings were used for one-on-one or small group work sessions where learners were actively engaged in problem solving, building robots, or programming with coaching from a mentor or teacher. Level 3 ratings were used when learners were working independently, either alone or in small teams, with minimal or no support from a teacher or mentor. The magnitude coding provided a dimension beyond simply marking where CT was observed to indicate levels of autonomy exhibited in observable CT behaviors. The magnitude coding recorded in the matrix spreadsheet provided a way to track growth over time in a concise visual display.

Structural Coding of Memos

The next stage of analysis was structural coding of the analytic memo text (Miles et al., 2020; Saldaña, 2016). Structural coding is used to group or categorize similar types of content for further analysis. The purpose of this stage was to collate related information and compare notes about activities, CT components, and the rationale for magnitude coding written in the memos. Multiple memo files, in Google Docs form, had been created for each session of the eight-week after-school program. The tools within Google Drive did not readily support the process of collating groups of similarly coded items in the memos such as everything noted about class discussions, or all comments related to a specific CT component. Therefore, one member of the team with extensive NVivo experience downloaded the memos as Word documents for coding in NVivo. Structural coding was used to collate related information in the memos including activity type, CT component, and level of independence associated with the magnitude coding (See Figure 3).

Figure 3
Screenshot of Structural Coding in NVivo



After structural coding was completed, it was possible to run queries to look for patterns across the data. For example, matrix coding queries were run in NVivo to examine the intersection of activity types and CT components as shown in Figure 4. The heatmap function helped us identify areas of prevalence across intersections of coded content. The underlying memo text could be opened by clicking each cell in the matrix to review the coded text. The combination of coding and queries was used to identify how CT was associated with different types of activities. For example, we identified a strong pattern of heuristics, algorithms, and logical thinking during programming activities. We found that students became progressively more autonomous and exhibited CT on their own as the program progressed. In addition, different activities promoted different aspects of CT. For example, when writing a computer program for the robot we consistently observed conditional logic and algorithms. Detailed results of the CT study will be reported in a separate manuscript since the focus of the present paper is on the methodological and technical issues that occurred behind the scenes.

Figure 4
Screenshot of Heatmap from Matrix Query in NVivo

	A : Heuristics	B : Conditional Logic	C : Algorithms	D : Data Collection
1 : Block Research	0	0	0	2
2 : Competition	0	0	0	0
3 : Discussion	0	6	2	4
4 : Journal Writing	0	1	0	2
5 : Lego Work	3	2	2	1
6 : Overview and Direct Instruction	0	2	1	1
7 : Programming and Testing	48	27	26	10
8 : Teamwork	0	0	0	0
9 : Transitions	0	0	0	0
10 : Watch Video	0	0	1	2
11 : Welcomes	0	0	0	0

Discussion

In this paper, we shared our approach for qualitative analysis of video data recorded during an after-school robotics program that was designed to promote CT. This research project required us to overcome various challenges that stemmed from conducting video analysis online, which was necessary due to a distributed research team, data security requirements, and limited access to campus during the COVID-19 pandemic. The main contribution of this work is to unpack how online analysis of video has been approached and to promote further discussion of audiovisual analysis where there has been a noted lack of detailed documentation about analytic and technical procedures (Silver & Patashnick, 2011; Smith et al. 2016). The key takeaways from this paper are found in the disclosure of how we addressed methodological or technological challenges that might be encountered when conducting studies involving online analysis of video. A central methodological issue in any video study is identifying what to look for in the video content and establishing a process to document and analyze what is observed. In our study, this meant first turning to the literature to identify several elemental components of CT. This gave us a starting point for what to look for in this contested domain where definitions and research evidence are evolving. Then, we had to identify which tools were available for this type of analysis. We considered the relative advantages of various technologies, including cost, ease of use, compatibility with the computers used to do the research (i.e., Some of us were using Mac and others on Windows operating systems), and functionality of the software for conducting qualitative analysis of online video. We learned that CAQDAS software is robust for desktop analysis but is limited for the type of online qualitative video data analysis we needed to do (Evers, 2018). Therefore, we combined online tools found in the collection of Google Drive applications with desktop CAQDAS to facilitate the full range of analysis procedures. This process was consistent with recommendations from the literature on selection and use of digital technologies for qualitative research (Davidson et al., 2016; Davidson & di Gregorio, 2011; Silver & Bulloch, 2017).

Further work is needed to develop methodological strategies and identify how to select or use technologies that support analysis of online video. The approach shared in this paper is only one of many possible approaches for solving the challenge of collaborative analysis of online video. There are other issues to examine further including those that Evers (2018) noted with online (i.e., in the cloud) analysis of qualitative data. These include benefits such as anywhere access or minimization of compatibility issues and potential problems such as data security and shared responsibility among researchers for safekeeping of data. In addition, CAQDAS tools currently offer limited or no support for online analysis of videos (Silver & Patashnick, 2011). More work is needed to develop new technologies or adapt analysis methods to work within existing technological capabilities. Additional methodological papers with examples detailing how researchers grapple with these challenges will promote development of solutions for online qualitative video analysis.

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Author Note

Chareen Snelson in an Associate Professor in the Department of Educational Technology at Boise State University. Please direct correspondence to csnelson@boisestate.edu.

Dazhi Yang is a Professor in the Department of Educational Technology at Boise State University. Please direct correspondence to dazhiyang@boisestate.edu.

Torrence Temple is a Doctoral Candidate in Educational Technology at Boise State University. Please direct correspondence to torytemple@u.boisestate.edu.

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