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Opportunities and Challenges of Using Video to Examine High School Students' Metacognition

Rose Bene

University of Calgary, rebene@ucalgary.ca

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Abstract

This article reflects on the opportunities and challenges of using digital video (DV) technology as a visual research tool in qualitative research. The ideas are derived from a multiple case study that examined ten high school students' metacognitive thinking as they created video representations of their own. The article begins with a brief history of visual research, and an introduction to the context, problem, and definition of metacognition within the study. This is followed by a literature review that examines the use of video in qualitative research and an explanation of the research questions and methodology. As revealed by the embedded video exemplars within this paper, many instances of students' metacognitive thinking, behavior, and feelings were inferred from video observations of students working on their video artifacts, discussing ideas with their group members, or responding to my questions. In the discussion, I explore the opportunities and challenges of drawing definitive conclusions about students' metacognitive thinking within video imagery and the multiple possible ways of interpreting this information.

Keywords

Metacognition, Visual Research, Digital Video, Multiple Case Study, Knowledge Representation

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Opportunities and Challenges of Using Video to Examine High School Students' Metacognition

Rose Bene

University of Calgary, Calgary, Alberta, Canada

This article reflects on the opportunities and challenges of using digital video (DV) technology as a visual research tool in qualitative research. The ideas are derived from a multiple case study that examined ten high school students' metacognitive thinking as they created video representations of their own. The article begins with a brief history of visual research, and an introduction to the context, problem, and definition of metacognition within the study. This is followed by a literature review that examines the use of video in qualitative research and an explanation of the research questions and methodology. As revealed by the embedded video exemplars within this paper, many instances of students' metacognitive thinking, behavior, and feelings were inferred from video observations of students working on their video artifacts, discussing ideas with their group members, or responding to my questions. In the discussion, I explore the opportunities and challenges of drawing definitive conclusions about students' metacognitive thinking within video imagery and the multiple possible ways of interpreting this information. Key words: Metacognition, Visual Research, Digital Video, Multiple Case Study, Knowledge Representation

For some time now, researchers who study human cultures and social lives have used photographs, illustration, paintings, and film as ethnographic tools to record human behaviors or daily phenomena in both naturalistic and structured settings. Predominant in both social and scientific fields, visual research methods and in particular, video, are becoming increasingly popular in the learning sciences (see Goldman, Pea, Barron, & Derry, 2007; Rose, 2001; Stanczak, 2007). Goldman (2007) surmised that video observations of classroom interaction help to expose learners' thinking thus enabling educators to design learning opportunities that meet students' needs. Other theorists like Clews (2003) conjectured that teaching and learning strategies that rely on visual research result in improved learning. According to Rosenstein (2002), the most frequent uses of video in education are: observation (including data collection and analysis), documentation of processes, video stimulus feedback and reflection, and video conferencing.

While there are different modes for visualizing student learning, the focus of this article is on digital video (DV). As a recording tool, DV lends itself quite naturally to visually documenting the everyday activities and complexities of students' and teachers' lives. Moreover, the ability for DV to collect rich data about students' cognitive, affective, social, and behavioral processes has led to new ways of analyzing, interpreting, and presenting data in the teaching and learning domains. The use of DV to try and capture student thinking does not come without its challenges, however. In this article, I take a reflexive look at the opportunities and challenges of using DV technology as a visual research tool for examining students' cognitive and metacognitive thinking. The findings and discussion focus primarily on how DV impacts data collection, analysis, and interpretation within a multiple case study of high school students.

The goal of the multiple case study was to observe and document students' metacognitive thinking while they were in the process of completing their own video creation

assignments. Research questions focused on the nature of students' metacognition in their specific learning environments, the potential of video creation activities to promote students' metacognition, and the potential of video documentaries to promote students' metacognitive reflections. The study demonstrated that video observation and documentation can provide new perspectives on how students think and engage with learning, thus making DV a powerful tool for facilitating teachers' understandings of their students' cognition and metacognition. Partial insights are provided for future educational researchers who wish to use DV as a visual research tool.

Definition and Interpretation of Metacognition for Study

Flavell's (1976) definition of metacognition was germane for this multiple case study because of its broad, equitable inclusion of both knowledge of and regulation of cognition. In his definition, thinking about the learning process itself and thinking about the products that are created are both considered legitimate forms of metacognition.

Metacognition refers to one's knowledge concerning one's own cognitive processes and products or anything related to them, e.g., the learning-relevant properties of information or data... "Metacognition [also] refers, among other things, to the active monitoring and consequent regulation and orchestration of these processes in relation to the cognitive objects or data on which they bear, usually in the service of some concrete goal or objective" (Flavell, 1976, p. 232).

Thus, metacognition is conceptualized as a multi-dimensional construct consisting of knowledge of cognition and regulation of cognition (Brown, 1987; Flavell, 1979; Paris & Winograd, 1990). These dimensions are interdependent, reciprocal, and necessary for learning (Schraw, 1998). Knowledge of cognition refers to knowledge about one's own cognitive processes and others' cognitive processes as well as knowledge about the domain, the task, relevant learning strategies, and knowledge about knowledge in general (Pintrich, 2002; Van Overschelde, 2008). Regulation of cognition involves metacognitive processes that facilitate and support the planning, evaluation, monitoring, controlling, and reflection on the learning process (Winne, 2005; Zimmerman & Schunk, 2001).

For the multiple case study, students created videos that represented their thinking on self-selected topics or stories and demonstrated their skills in video production. The learning process that was involved and the resulting video products facilitated the examination of their metacognitive thinking and self-regulated practices. The central premise of the study was that students' concrete manifestations of their thinking (i.e. scripts, camera work, performances, and video) edits represented their first order cognitions whereas their verbalizations, deliberations, feelings, or actions regarding the content, process, and various artifacts they created represented their second order thinking or metacognition. Thus, students' thinking was made conscious and available for discussion, reflection, monitoring, evaluation, and revision through their video work and video artifacts.

Students' videos and work represented their thinking on several levels. First, their ideas and thinking about their topics, information pieces, or stories (i.e., the scope, quality, and understanding) of content was embedded in their video artifacts. Their videos also represented their thinking about the different modalities and semiotic resources needed to create their videos and how they assembled these into meaningful end products. In addition, the actual production process represented their thinking about how to go about planning, creating, evaluating, reflecting on, and changing or regulating their video products.

Literature Review

The use of DV in educational research has been facilitated by the availability of lightweight, inexpensive digital video equipment. Video observations of classroom interactions constitute an important means of gathering data and constructing knowledge about teaching and learning. The following literature review provides a few examples of how video has been utilized in the classroom setting.

Zaritsky (2007) took advantage of video's capabilities for providing different angles, zooming into, and visually highlighting K-6 Math students' problem solving methods, thus enabling teachers to better understand their learners' cognitive processes. Koschmann, Stahl, and Zemel (2007) used video analysis to study how students make meaning of their own actions and negotiations during learning interactions. Likewise, Heath, Hindmarsh, and Luff (2010) explored video as a tool for repeatedly scrutinizing and conducting fine-grained analysis of moments of social life and visible conduct in the classroom including gaze, gesture, facial expression, body posture, movement, and carriage.

In another inquiry, Green, Skukauskaite, Dixon, and Cordova (2007) used video to focus on the discourse and outcomes of learning groups as well as how group members construct knowledge. With each subsequent analysis of their video recordings, the authors discovered a different set of interactions, thereby uncovering layers of co-occurring knowledge construction by both individuals and groups.

Using recorded episodes of research participants in action, and inviting them to comment on what is happening in those episodes is another way to gather and analyze data on learning. Goldman and McDermott (2007) invited teachers and students to code video recordings of their own classroom interactions. This empowered both groups to think of *education* in a different light. McTavish (2008) recorded a student reading to her, then played the video back and asked the child to explain what she was thinking and doing when she was trying to make sense of the reading content. The video triggered multiple instances of metacognitive thinking on the part of the child.

Video stimulus sessions can also assist teachers to become more reflexive about their own practices. For example, Roth (2007) found that video analysis of his own teaching resulted in a whole new perspective on pedagogical practice in the classroom. Erickson (2007) studied teacher's reactions to naturally occurring classroom events in minimally edited short segments of video. The analysis revealed how pedagogical practices and social cultural contexts influenced teachers' understanding of teaching. Similarly, Sherin (2007) showed that teachers' increased attention to students' comments or thinking rather than to pedagogy within videos of classroom learning had a powerful impact on their interpretations of the events.

Employing video as an observational tool has a long tradition within pre-service teacher education. Findings from several studies revealed that pre-service teachers were able to think critically about their course content, their knowledge of pedagogy, situated teaching practice, and other issues around schooling as a result of watching videos of themselves teaching or creating their own videos about teaching and learning (see Hall & Hudson, 2006; Norton & Hathaway, 2010; Sweeder, 2007; Tochon, 2007; Yerrick, Thompson, McLaughlin, & MacDonald, 2011).

The literature also speaks to the ways in which researchers manipulate video to illustrate their findings. By slowing, freezing, zooming or scrolling video images and adding gestures or annotations, Stevens (2007) showed that the viewer can be guided to focus on a specific aspect of the visual image and that these *Video Traces* are very useful in interactional analyses. In a different format called *Video Paper*, Beardsley, Cogan-Drew, & Olivero, (2007) integrated text, images, and video into a cohesive, interactive, multimedia document.

Readers of *Video Paper* can choose to read the text and click on the play buttons that trigger the video or watch the video and click on the links to the text.

A further affordance of video is that it provides the ability to store, share, retrieve, manipulate, and construct new interpretations of the data. Examples of the trend toward building video sharing vehicles include websites (Fishman, 2007; Pointer Mace, Hatch, & Iiyoshi, 2007); webcasts (Baecker, Fono, & Wolf, 2007); online video databases (Goldman, 2007; MacWhinney, 2007); and integrated, temporal multimedia data systems (Hay & Kim, 2007).

Very few investigations in the literature have used visual observation methods to explore whether or not video creation impacts students' thinking and metacognition (Barp, 2006; Cheng & Chau, 2009; Dixon, 2009; Kearney & Schuck, 2006). Even fewer have documented students' monitoring, control, and evaluation of their thinking while in the process of completing video assignments.

One of my intentions of using DV as an observation tool and inviting participants to verbalize or explain their thinking during the video creation process was to work towards filling this gap in the literature. Furthermore, by embedding exemplars of students' thinking into the written document, others are able to examine the data and draw their own conclusions about students' metacognitive thinking and skills during video creation.

Learning Theories and the Role of the Researcher

During the process of video creation, learners construct personal interpretations or representations of their knowledge in a multimedia format. The learning theories underpinning this process are constructivism and constructionism. Constructivism is based on the idea that individuals create meaning from their external and internal cognitive and affective experiences. Knowledge is constructed as the learner builds connections between prior knowledge and new knowledge.

Constructionism takes these ideas further by proposing that knowledge must be actively constructed in the mind of the learner through the creation of artifacts or products (Jonassen, Myers, & McKillop, 1996). In constructionism, emphasis is placed on the process of learning as well as the outcomes of learning. The processes involved in video production tie in nicely with both constructivism and constructionism by providing students with the means to construct and represent their knowledge in a visual form.

Two other theories influenced the study. One is social cognitive theory or the notion that learning takes place within a context, whether social, environmental, cultural, or personal (Bandura, 1986). The other is sociocultural theory (Vygotsky, 1978) or the idea that learning is mediated by tools and significant others. Winne (2005) encapsulated these theoretical ideas in the following way, "learners are agents who construct knowledge in the changing milieu framed by their knowledge, beliefs, motivational dispositions, and other propositions 'in' their minds plus information they access in their environment" (p. 563).

As a constructivist, I believe that we create meaning from experiences and interactions with our external and internal contexts, building on what we already know. I also believe that learning is complex, and emergent (Davis, 2008), and that knowledge is ever changing, expanding, and created individually or in partnership with others, technologies, and contexts. These epistemological beliefs and learning theories impacted the way in which I conducted the study. In my role as observer and data collector, I documented the ongoing discussions, actions, and interactions of students working on their videos. As a participant in the process, I asked students to explain what they were thinking and doing and analyzed and interpreted their responses.

Methodology

Research Questions and Parameters of the Study

The opportunities and challenges of using digital video as a research tool were derived from a multiple case study that I conducted on students' thinking while they were involved in creating their own video productions for their courses. My research explored the following questions among others:

- 1) What is the nature of students' metacognition within a particular learning context, i.e. students involved in creating videos for their school assignments?
- 2) How might video creation promote students' metacognition?
- 3) How might viewing a video of themselves trigger students' reflection on and understanding of their thinking?

Since the study revolved around thinking and learning, and because these activities are encouraged in schools, it was logical to work with students in a school environment where I could delve into these activities in a more meaningful way. I chose case study methodology because of the opportunity to take a more detailed and interpretive approach to examining the thinking of a few individual students within a bounded setting (Hamel, Dufour & Fortin, 1993). According to Yin (2005) "case study is the most appropriate methodology for examining the "richness and complexity of everyday life in a school" (p. 4). In order to proceed with recruitment, I obtained full institutional ethics approval from the University of Calgary.

Purposeful Recruitment and Sampling

Following Merriam's (1998) recommendations for "purposeful sampling" (p. 61), I decided to recruit high school students for the study due to their potential for engaging in formal operational thinking (Piaget, 1972), their perceived ability to articulate their thoughts and ideas about thinking, and their facility with digital technologies (Kennedy, Judd, Dalgarnot, & Waycott, 2010). Young people in high school are also concerned with establishing their own identities and forming strong bonds with their peers (Erikson, 1968), attributes that are necessary for metacognitive thinking and collaborative learning

The high school, in which the study was conducted, follows a self-directed learning model that encourages and teaches students to take responsibility for their own learning. In this environment, students are able to customize a learning program around their learning preferences, abilities, and interests. They are also able to complete the coursework at their own pace instead of attending classes where the pace and schedule are established by a classroom teacher.

To recruit the students, I attended several introductory seminars in Career and Technology Studies Audiovisual (CTS AV) and English Language Arts (ELA) where I presented my research study and asked for volunteers. The final multiple case study consisted of ten students, five ELA students and five CTS students as well as six of their group cohorts. ELA students were required to illustrate their understanding of media literacy by producing a video that presented multiple perspectives on a particular topic. CTS students were required to demonstrate their ability and skill in assembling a short video that communicated a message or story. Informed consent from parents allowed me to video record students' images, comments, and work. As a consequence, I recorded as much of the process of

students working on their videos as possible, focusing primarily on students' verbal and nonverbal thinking, actions, and feelings towards their ideas, and video artifacts, and interactions with each other and the technology. This resulted in an enormous quantity of rich data.

Data Gathering Methods

A number of researchers recommend the use of multiple or concurrent methods for measuring metacognition (Anderson, Nashon, & Thomas, 2009; Veenman, 2005; Veenman, Van Hout-Wolters, & Afflerbach, 2006). Following this advice, I employed both offline measures (e.g., interviews, the examination of student artifacts, and video stimulus reflection sessions) and online measures (i.e., videotaped observations, verbalizations, and question-prompted conversations) in the study. For each of the cases and their respective groups, I observed, discussed, and examined their thoughts, ideas, feelings, and actions to get a feeling for their explicit and implicit cognitive and metacognitive thinking during the video production process. Both verbal and nonverbal data were analyzed. The collected data were triangulated with the different video artifacts produced by the students and other relevant school documents and learning guides.

Most of the case study participants produced their videos within the school environment amidst the general hustle and bustle of such a setting. Without permission to video the general student body, I was restricted to using a handheld camera, focusing closely on the case study participants. During postproduction, I sat next to participants as they worked on their videos in the multimedia computer room facing the computer screens. This way, I could capture their verbalizations, discussions, and responses to my questions as well as observe what they were doing. On occasion, when no other students were present, I zoomed out to offer a different perspective on participants' work.

Data Analysis

Given the large volumes of multimodal data in video, Rostvall and West (2005) recommend that, "choices...be made about how to represent, analyze and interpret data systematically" (p. 3). They recommend using a theoretical framework to anchor the analysis in a particular discipline and literature. Many researchers subscribe to either editing video into discrete meaning making blocks or clipping naturally occurring segments (Lemke, 2009; Crichton & Childs, 2005). In this multiple case study, I focused on the macro-level categories within the literature on metacognition to code the data deductively. See Table 1 for a listing of the macro-level coding categories used in the deductive analysis (Bene, 2013).

During the inquiry, I implemented a cyclical, iterative process of recording, reviewing, and analysis. I reviewed the videos repeatedly choosing segments or clips that I believed illustrated the macro-level categories of implicit/explicit knowledge of and/or regulation of cognition. Initially, each case was considered individually and then a comparison of cases was undertaken to determine any common macro-level themes. This provided important evidence for determining patterns of thinking and generalizations across cases (Yin, 2003). I looked for both verbal and nonverbal examples of metacognitive thinking, skills, feelings, and behaviors (i.e., exclamations of satisfaction, delight, dismay or frustration and nonverbal expressions such as body language, eye gaze, gestures, pointing, and posture) as well as collective or distributed metacognition.

Table 1. Listing of the Macro-Level Coding Categories Used in Data Analysis

Main Category	Macro or micro-level categories	Variable, Component, Factor
Awareness or Consciousness	Explicit knowledge (articulates or demonstrates thinking about thinking actions, feelings, processes, content, or products)	I know how to do this. I know what kind of learner I am. I know what learning strategies I use. I know the details of this task. I think about my thinking. I know the kind of thinking or reasoning I use. I think or reflect on my ideas, feelings or actions. I am going to do this. Here is my plan for this. My goal is to... I am doing this because...
Contextual Conditions	Identifies components in the learning context that impact completion of task Identifies sociocultural influences on beliefs, values, and thinking	Instruction, time, resources, social context, subject, task Parental influences, beliefs, societal influences, peer influences
Cognitive Conditions	Explicit or implicit knowledge of self as a learner	Memory capacity, cognitive load, beliefs, skills, abilities, learning preferences, domain knowledge, prior knowledge, task knowledge
Affective Conditions/Beliefs	Explicit or implicit knowledge of motivations, values, beliefs, and emotions	Epistemic beliefs, motivation, self-efficacy, self-esteem, confidence, emotions, academic attributions
Knowledge of Cognition	Declarative Knowledge – Can declare or demonstrate knowledge of person, task, and strategy variables Procedural Knowledge – Can declare or demonstrate knowledge of how to undertake task and which strategies to use	Task, subject matter, feelings, skills, abilities, learning strategies, motivation, beliefs Understands the parameters and requirements of the task Knows how to undertake the task Knows how to make use of appropriate strategies for task completion
Regulation of Cognition	Conditional Knowledge – Can declare or demonstrate reasons for strategies Planning and goal setting Monitoring (includes micro-level judgments of memory; learning, etc.) Controlling or regulating Evaluating and reflecting	Knows why, when, and where to use strategies Sets short-term-sub –goals and long-term goals, standards for achievement, timelines Gathers required sources, selects strategies, schedules time Monitors goals, time, standards, strategies, process, content, understanding Motifies goals, time, standards, strategies, processes, content, etc. Evaluates and reflects on process, content, quality, achievement
Shared/Social Metacognition	Collect or shared cognition or metacognition	Collective or shared metacognitive awareness, thinking, and co-regulation or other regulation
Non Verbal Modes	Body language or movement	Posture, gestures, leaning, gaze, focus
Verbal Modes	Verbalizations or thinking aloud	Content, tone, pitch, emotion, pauses, inflection

Following this, I wrote up analytic descriptions or *analytic narratives* (Nicholson, 1999) that portrayed the action and natural sequences of an event, providing the reader with a vicarious experience of having been there. These analytical narratives along with direct quotes, descriptions of the processes, and actual video segments functioned as credible sources for subsequent interpretation. The direct quotes served to represent the participants' perspectives in their own words and the video excerpts illustrated the events that took place. Wherever appropriate, I also used segments from the students' videos to reinforce the

metacognitive thinking that emerged from the primary data. Exemplars from the data are provided in the discussion section. In combination, all these data can be considered *thick* descriptions (Geertz, 1973), providing a multi-dimensional view of the metacognitive phenomena that I observed and inferred in participants.

Results

The results of the study are stated as responses to the research questions. In response to research question one about the nature of students' metacognitive thinking within the particular learning context; I tried to gain an overall sense of students' cognitive and metacognitive thinking during the process of creating their own video representations for their different course assignments.

Using the video observation data and the macro-level categories within the framework, I was able to infer several occurrences of students' self-knowledge, metacognition, and self-regulation. Students' thinking and talking about their beliefs, learning strategies, or prior knowledge were considered examples of their knowledge of cognition. Students' thinking about and modification of the planning, recording, and editing (changing the modalities and symbolic or semiotic resources) to create meaning, different perspectives, or flow in the content of their initial ideas, scripts, or edited videos were considered examples of their regulation of cognition. Students' thoughts, feelings, and actions toward their ideas, video scripts, storyboards, video footage and edited videos were noted as they worked on their videos and engaged in discussions with other group members. When I questioned them about any of their thinking, actions, or discussions, all students were able to articulate what they were thinking or doing and why. Table 2 illustrates the extent of students' macro-level metacognitive and regulatory thinking skills and behaviors over the course of the study (Bene, 2013).

As the data illustrates, some students appeared to be more metacognitive than others in certain areas. For example, Bonny and Catherine possessed greater knowledge about their learning strategies than did other students. Tessie's and Kyle's strong beliefs about education impacted the way they went about their video work. Amy's and JM's knowledge of semiotics and Catherine's, Ashley's, and Billy's knowledge of meaning making contributed to the overall quality of their end products. Those students who worked in groups tended to show more instances of decision-making, planning, monitoring, evaluating, and controlling than those who did not. This resulted in increased instances of distributed and shared cognition and metacognition among group members.

These findings are supported by other research that examined high school students' implicit or tacit use of metacognition and self-regulated learning. Moline (2009), for example, found that even though students don't appear to plan their learning activities, they nevertheless have a plan of some sort. In Leutwyler's (2009) study, students reported using certain learning strategies repeatedly during their high school years.

In response to question two, how might video production promote students' metacognition, the data revealed digital video's potential to engage and sustain students' interest, thereby promoting more thoughts, ideas and discussion about what they are thinking, doing, and creating. According to Reeves (1998), "multimedia can stimulate more than one sense at a time, and in doing so, may be more attention-getting and attention-holding" (p. 22). Students received information from a variety of sensory inputs, visual, auditory, kinesthetic, semiotic, each other, and were required to make ongoing decisions based on these inputs during the different phases of video production.

Table 2. Number of Metacognitive or Self-Regulatory Thoughts and Actions Observed, Verbalized or Inferred by Researcher

Construct	Student									
	A	B	C	D	E	F	G	H	I	J
Beliefs/Motivation	2	1	8	6	3	1	1	3	2	1
Declarative knowledge										
Knowledge of self	5	4	4	2	6	5	5	3	3	4
Knowledge of learning	10	3	2	3	5	8	2	3	3	5
Knowledge of task	4	2	5	3	5	3	4	1	3	4
Knowledge of domain-video	8	8	12	8	14	12	12	9	11	14
Knowledge of context	3	3	3	2	1	6	2	2	1	1
Knowledge of semiotics		2			11	5	4	4	2	10
Procedural knowledge	10	14	15	12	15	16	10	11	13	14
Conditional knowledge	4	5	4	4	8	4	4	5	3	8
Regulation of cognition										
Goal & vision	4	2	1	1	2	5	1	1	3	2
Planning	14	16	5	15	4	15	5	5	14	4
Monitoring & control	20	18	5	13	14	18	12	5	6	8
Evaluating	5	12	2	4	6	15	4	7	4	8
Reflecting	9	10	10	10	9	8	12	9		10
Higher order thinking										
Critical thinking	5		5	3						2
Decision-making	49	39	29	43	40	54	37	32	35	44
Problem solving	6	3	1		1	2	2	2	1	
Creative thinking	5	4	2	4	13	10	7	6	3	8
Meaning Making			1		5	4	2		4	4
Shared metacognition	<u>20</u>	<u>5</u>	<u>0</u>	<u>4</u>	<u>0</u>	<u>30</u>	<u>5</u>	<u>0</u>	<u>11</u>	<u>0</u>
Total # instances	183	151	114	137	162	221	131	108	122	151

Note. Each student is identified by a letter from the alphabet: A - Bonny; B - Ashley; C - Tessie; D - Kyle; E- Amy; F - Catherine; G - Lenny; H - JR; I - Billy; J - JM.

The data also revealed that the editing software's capability to impart immediate feedback with regard to students' decisions and actions helped facilitate their monitoring and regulating functions. Furthermore, the software's built-in capacities for storing, organizing and sharing information enabled students to download some of the cognitive load that was

required for video creation, thus facilitating their planning, problem solving, and decision-making.

In response to question three, how might viewing a video of themselves trigger students' reflection on and understanding of their thinking, the video observation documentaries that I constructed triggered students' recall of the actual events ("I remember that"), verbal acknowledgement of the events ("editing is a very lengthy process"), and nonverbal reactions (leaning on their hands or moving away from the computer monitor while watching the video of themselves). Most of the students remarked that the documentaries validated their thinking ("I still think the same way as I did before").

Since students had never seen the documentary videos before, many of them were distracted by how they looked and sounded on camera. Rather than focusing on what they were thinking or learning, they focused on their appearance or how they interacted with group members. Despite these shortcomings, these video reflection sessions served as member validations of the research that was conducted (Lincoln & Guba, 1985; Yin, 2003). Students confirmed that the video documentaries accurately represented their thinking, comments, and behaviors, as well as the processes they experienced as they created their videos.

Discussion

Using video as a visual research tool to investigate metacognition in this multiple case study presented both challenges and opportunities. In most instances, the opportunities that video afforded were accompanied by concomitant challenges. This interrelationship is explored in further detail in the following sections on data collection, data analysis, and interpretation. In each section, the opportunities will be presented first followed by a discussion of the challenges of using video as a visual research tool.

Opportunities of Using Video during Data Collection

Capturing More than we Can Consciously Register in the Moment

Video provides the opportunity to capture more information than humans are capable of consciously registering. Even under the most restricted circumstances, the video camera is capable of capturing aspects of images or events that our consciousness cannot fathom in the moment or accurately remember. Martin (1999) confirmed the power of video to "extend and enhance the possibilities of observational research by capturing moment-by-moment unfolding, subtle nuances in speech and non-verbal behaviour ...not just 'part of the whole picture' ... better than observer notes" (p. 81).

The following video excerpt reveals much about how nonverbal behaviors, verbal interactions, and social dynamics contribute to students' metacognitive and SRL development. Had I engaged in traditional observation and note taking to record this scenario, I would have likely missed many of the subtle, nonverbal behaviors, and verbal exchanges that occurred among the research participants.

The three ELA students in this sequence are involved in producing a short news item. In the clip, the students have stopped recording and are monitoring their video footage and framing by evaluating how it looks, captures their performances, and meets the standards of a typical newscast. Each of the participants is focused on the camera viewfinder on which the recorded footage that represents their first order thoughts and actions is playing. They react both nonverbally through their individual gazes, smiles, body postures, head tilts, gestures, and subtle movements as well as verbally via conversation, acknowledgements, and varying

vocal responses or meta-level reactions to what they are seeing. Based on this monitoring experience, the students decide to regulate their actions by changing the camera framing and redoing the segment.

Capturing the components of complex interactions and ideas

Because of its ability to provide aural, visual, and behavioral information, video is an important and flexible instrument for collecting information on complex interactions. For example, it is capable of zooming into the subject, changing the speed of the action, and magnifying steps in complex procedures. Furthermore, it is ideal for recording ideas or actions that are difficult to describe in text and for inviting viewers to scan for what is important in the image (Schwartz & Hartman, 2007) and come up with their own interpretations of what they see.

The next video sequence illustrates how one CTS student managed to incorporate a highly complex idea into his video about a student walking to and from study class. In the clip, JM discusses how he drew upon an image in the video frame to create a metaphor about the student's actions and motives. He explains that he intentionally extracted this idea from the imagery for the purpose of fostering "open interpretation" of his video. Using the zoom and focus functions on my camera, I was able to capture JM's idea about "dimensions" and understand its importance for generating difference reactions to his movie.



Challenges of Using Video during Data Collection

Capturing Metacognition on Video

Since thinking is typically an internal process, it is difficult to measure, let alone capture on video unless students are verbalizing their thoughts or sharing their ideas with other group members. Even online measures such as log file recordings, observations, and eye gaze/movement monitoring tend to capture overt behaviors, and therefore internal thoughts or feelings must be inferred from the participants' verbalizations and actions. The challenge is to bring the consciousness of thinking about thoughts, feelings, and actions to the surface in what Schön (1987) refers to as *reflection in action*.

In order to do this, I asked students' to explain their thinking and what they were doing, engaging them in conversations during the video production and post-production sessions. Other studies have demonstrated the efficacy between students' explanations of what they are doing and why and their conceptual understandings, knowledge construction capability, and self-regulation of learning (Cox, 2011; McNamara & Magliano, 2009; Siegler & Lin, 2010).



The following is an excerpt from one conversation where I questioned the student about his thinking regarding the inclusion of multiple perspectives in the video, one of the learning objectives for the ELA video task. My questions are italicized and bolded.

Do you have multiple perspectives in the script?

(Student points to the script on the screen and scrolls), “Right here, it actually lists a couple of negative side effects such as how it can cause cancer. It should not be used by people with schizophrenic disorders. It talks about the bad side of marijuana, I guess.”

You think you have both sides then?

“Both sides, it’s probably biased towards one side but both sides are projected so if someone wants to learn more about it, they can always go out and learn themselves.”

So what do you think of your thinking on multiple perspectives?

“It’s effective.”

This student’s responses can be interpreted as metacognitive evaluations of the primary thoughts in his script based on both verbal (illustrated above) and nonverbal cues such as posture, pointing towards and touching the screen, voice intensity, and eye gaze. While the student acknowledged that his thinking might be biased in one direction, he still believed that he had represented both sides of the issue. The above excerpt illustrates that the student was capable of thinking metacognitively about the content in his video, but only with the appropriate scaffolding of the researcher.

The camera’s impact as an observation tool

Many researchers have commented on the impact that using a camera as an observational tool has on research participants (Goldman-Segall, 1998; Pink, 2007; Stanczak, 2007). A camera is not only a technological object; it interacts with the other participants and mediates the dynamics within a particular context. Shrum, Duque, and Brown (2005) refer to this as a *videoactive* context, where an intrusive technology such as a video camera is an *actor*, that takes on the “identity of the researcher or that of the subject and in the next instance ...a third party observer, a meta-subject occupying the focus of the videoactive context or meta-researcher hovering inconspicuously over the research scene” (p. 8). In this case study, there is little doubt that the video camera influenced the way that students responded to me, inducing them to think, answer, or behave more carefully than if I had not been recording them.

Once the camera became part of the operational norm and context, however, participants tended to ignore it. Due to students’ familiarity with video technology and frequent use of it for their own personal creations, there was a greater acceptance of the camera. When addressing me, they looked over or through my camera as if it were non-existent. Shrum et al. (2005) referred to this as a *fluid wall* between the researcher, participants, and camera, wherein observations, behaviors, and interactions are all intermingled and therefore less conspicuous.

Camera placement and framing

Technical and logistical decisions such as camera placement, how many cameras to use, whether to move with the action or remain static, how to capture sound, and what focus or framing to use to capture key events are other challenges for those using video as a research tool. The epistemological and ontological perspectives of the person holding the camera also impacts how the image is captured, presented, and manipulated. Acknowledging the subjectivities involved in camera placement and framing when undertaking video research helps researchers to establish the “trustworthiness” of the findings (Green, Skukauskaite, Dixon, & Cordova, 2007).

When I first began planning the multiple case study, I thought that employing a wide frame in what Loizos (1993) described as “whole people, whole bodies in whole acts” (p. 7) would be the best way to capture everything that occurred. I rationalized that this framing would enable me to record the *big picture* of what the students were doing on their video projects (group discussions, filming sessions, and so on). I had also planned to use more than one camera to capture alternate and close-up angles on student work, behaviors, and reactions.

Because there were other students milling around the areas where the participants were creating their videos, I was prevented from using any wide-angle shots. In order to avoid gathering footage of these other students, I was obliged to use a handheld camera and stay as near to the case study participants as possible. As a result, the camera images are often focused very closely on the participants’ faces or their computer screens, leaving out the peripheral clues and contexts of students’ behaviors, movements, and interactions. Occasionally, when there were no other students around, I was able to provide a wider perspective of participants’ production activities.

Social cognitive and sociocultural theorists tell us that social context has a profound impact on the behavior and motivation of participants. This was particularly true in this multiple case study as participants interacted with and were frequently distracted by other students. Widening the camera frame to reveal participants’ embodied movements as well as their interactions with others would have provided a more complete understanding of their thoughts, feelings, and actions in those situations.

This issue was resolved to a certain extent by describing the contexts in which the participants worked. As well, the background sound from the camera segments provided a trace reminder of some aspects of the context surrounding the participants. Ultimately, however, the final images were only a partial glimpse of what actually occurred.

Creating an equal partnership with participants

During the study, I attempted to develop a balanced, equitable relationship with participants, spending prolonged periods of time with them during the production process, being a good listener, and open to any ideas that might arise. The students, themselves, also exercised a certain amount of personal power and freedom in choosing how and when they were going to interact with me.

Nevertheless, a more participatory or critical methodology such as action research, in which participants were involved in the actual design and implementation of the study, might have generated a more equitable relationship with them. Furthermore, students might have provided more reflective comments about their involvement in the study if I had asked them to keep electronic diaries or video journals. Encouraging students to turn the camera on the researcher at various points in time might also have empowered them to contribute their own perspectives about the study’s objectives and processes.

Opportunities of Using Video during Data Analysis

Revisiting video records repeatedly

In addition to greater lasting quality than both analogue video and text, digital video is also a permanent record of the images and events that transpired, which can be revisited as many times as needed to delve deeply into, confirm, or derive multiple interpretations. “Researchers can view recorded events as frequently as necessary in flexible ways such as real time, slow motion, frame by frame, forward and backward and attend to different features” (Powell, Francisco, & Maher 2003, p. 408). Video segments can also be edited, annotated, stored in databases, and retrieved for future use.

For this case study, I viewed the video observations of each participant repeatedly with the intention of scrutinizing the data for examples of knowledge of and regulation of cognition. Once I had clipped and coded what I inferred were examples of metacognition and self-regulated learning, I reexamined the clips several times to ensure that they met the requirements of metacognitive thinking, feeling or behavior, (i.e., there were “observable shifts in cognition ... to a focus on an aspect of the cognition itself or emotion or a focus on the regulation and control of thinking” (Larkin, 2009, p. 152). The final



results revealed many instances of students’ metacognitive thinking, behavior, and feelings.

Using multiple forms of analysis

Due to its richness and multi-dimensionality, there are numerous ways in which video can be examined and analyzed. For example, by examining the nonverbal vectors of body motion and eye gaze in the following segment between Ashley and Alex, an interactional analysis can be carried out on the way participants directed their attention to their video and each other.

In my field notes, I noted that Ashley and Alex are sitting at a computer station in the multimedia resource room, with Alex on the left manipulating the keyboard and Ashley on the right. In the camera frame, we only get a brief glimpse of Ashley in the left hand quadrant. Both are focused on and facing the computer screen. Ashley is very animated, (quick head movements and intensity in voice level), and gestures towards the screen to indicate what she is talking about, briefly looking at Alex and leaning towards him to emphasize her statements. She pans her hand across the screen to illustrate the specific shot she is looking for and wants to add. The clip also reveals much about their verbal interaction, who speaks to whom first (Ashley to Alex), how Alex responds, how Alex’s response triggers another response from Ashley, and how they primarily direct their verbalizations to what they see on the computer screen.

The fact that video records audio simultaneously with action and context allows researchers to study meanings as constructed through the semiotics of signs and symbols. Semiotic analysis reveals the choice of symbolic systems and modalities that the students used to express the meaning within their videos. The frame on the right, for example, is the image that is missing from the above video segment. It is of a student



working diligently at a computer terminal surrounded by other students. The signs in the image (the student(s), the computer desk, the computer screen, the student's hand on the mouse) are recognizable everywhere as signifying a classroom setting. When spatially and temporally aligned, the image in combination with the audio "School has always been a place where youth can learn, grow, and acquire the skills and knowledge necessary to become successful and reach their full potential" reinforces the intended idea of a typical school context. In searching for this missing image, the students are monitoring and regulating their learning processes. Both students understand that they need to align the correct image with its corresponding audio so that their finished product conveys the appropriate message that has meaning for their audience.

Other possible ways of analyzing this video segment include examining discourses that inform the reader of the spoken and written languages used, the dynamics of text production, distribution, and consumption, and the sociocultural context of the particular situation (Rose, 2007). If we look at the order of discourse and role identities within this particular video clip, it appears that Ashley is the leader of the group and is directing the actions of others. This makes sense within the sociocultural context of video production where one person typically takes the lead in ensuring that the video is assembled as per the original thoughts and ideas outlined in a script. As the editor, Alex, also plays a key role in ensuring that the images and audio are combined appropriately to achieve the desired outcome. This segment therefore reveals that video production is heavily reliant on the thinking, shared metacognition, and cooperative action of team members.

In conclusion, many different types of analyses are possible for teasing out the metacognitive moments within video imagery. Which analyses are used depend on the objectives of the study and the researcher's own theoretical and epistemological beliefs.

Challenges of Using Video During Data Analysis

Analysis is time consuming and never complete

As mentioned above, there are many possible methods for analyzing video data in qualitative research. Some researchers make use of various computer-assisted qualitative data analysis systems (CAQDAS), to help in coding, storage and data organization, deriving themes and interpretations, and report writing (Weitzman, 2003). Others recommend repeated viewings where one simply sits, looks, and makes handwritten notes (e.g., Pirie, 1996). Some recommend making detailed transcriptions of the video and dialogue (e.g., Powell, Francisco, & Maher, 2003) while others prefer using video excerpts to support their research claims (see Crichton & Childs, 2005, p. 3). The method of analysis that is chosen is often based on the researcher's biases or interests. As Pirie (1996) intoned, "we look with a purpose, we see what interests us" (p. 3).

Rather than using a particular CAQDAS, I chose to analyze the data by repeatedly viewing, clipping, and coding certain segments that seemed to resonate as examples of knowledge or regulation of cognition, transcribing certain events and quotes, and making analytical narratives as I went along. It was through this process of going back and forth that I got a sense of what could be inferred from the data. The process was messy and time consuming, taking hours to review a single sequence. Also, regardless of the many times that I viewed a sequence of video using the macro-level coding categories from the literature for structuring the analysis, there was always more to see in the frame and different ways of looking at it.

The influence of beliefs and theoretically-driven inferences

The theoretical underpinnings of the research and the researcher's epistemological beliefs play a huge role in determining how the analysis is handled. Azevedo, Moos, Johnson, and Chancey, (2010) reinforce this idea, claiming, "[The] coding and clipping [of] video segments is based on theoretically driven inferences about where the particular metacognitive or self-regulatory behavior begins and ends" (p. 218).

My use of the macro level categories from the theoretical literature on metacognition along with my beliefs about how video creation represents cognitive and metacognitive thinking formed the basis for my analysis and interpretation in the study. The following segment is an example of how these beliefs influenced my analysis.

In the segment, the two girls are editing and assembling the shots for their video, adding in the elements that will make their video look like a professional newscast. The segment shows the students evaluating and suggesting changes to their first-order thinking, now represented in the images on the computer screen. By inserting a title for the on-camera guest, the students are ensuring that audiences will understand their video. As well, they are regulating their ability to follow the correct protocols and accepted standards of newscast production.

The segment also illustrates that metacognition is not just an individual phenomenon but is co-constructed in collaborative contexts. Thus, group member interactions add another layer of complexity to undertaking the analysis of video. This is where new theories on collaborative learning, distributed cognition, and social metacognition are helpful (Efklides & Misailidi, 2010). A powerful dynamic of distributed cognition and shared metacognition appears to take place in this segment. When the first student offers an idea or detects something that requires attention, the other student is prompted to refocus her attention and follow through with a revision or adjustment of her thinking and subsequent actions. Therefore, the final video is not just a product of one mind; rather it is a negotiated co-construction of all the minds that contributed to it, a collective consciousness, cognition, and metacognition.



Combing through the nested layers of video

The meanings within a video are created and conveyed when shots are placed in relationship to each other. Diefenbach (2008) describes how the combination of two shots creates "a meaning both outside of and greater than the sum of their parts" (p. 99). Video also incorporates several symbol or sign systems that embody transformations in motion, time, space, sequence, and perception through camera movement, visual composition of the shot, sound manipulation, and editing techniques. The fact there are many possible ways of combining these components adds to the challenge of analyzing video.

In the following example, the participant clearly describes the way in which she edited the two shots together to convey a more powerful message about prescription drug abuse. The female in the image is manipulating some pills in her right palm. We know from previous segments that this person is experiencing some



distress. While we never see the person actually taking the pills, the sequenced shots that show her picking up the class on a wide angle and putting it down on a close-up to elicit the appropriate conclusion from the viewer, i.e., that the person has in fact taken the drugs.

Excerpts of analyzed video must therefore provide the viewer with enough details about the event that viewers can make up their own minds about what transpired. The more the segment is manipulated, the less it is like a natural unfolding of events. During the clipping and coding of segments from the original video observation records, I tried to maintain the integrity of the excerpts in their original form. For example, I included the participant's explanatory voice over of the above segment so that viewers would understand the thinking behind the edited clips. Without it, different interpretations of the sequence may have resulted.

Opportunities of Using Video During Data Interpretation

Using video to validate the findings

Despite its constructed nature, video can be used to illustrate and validate critical aspects of the findings (Walker, 2002). Video has a greater believability factor because viewers are able to see the imagery for themselves.

Visual representations have a more taken-for-granted obviousness, a greater power to convince. They are granted a greater degree of trust, thus confidence in their validity is normally attained more readily than in the validity of the written word. It has a potential for increasing the immediacy of understanding (Davies, 2008, p. 130).

In this multiple case study, I used various video clips to establish my premise that the thinking, evaluation, and changes that the students made to the ideas, modalities, symbolic signs, presentation options, and production processes were metacognitive acts. Actual video clips of participant voice, gesture, expression, body movements, and actions helped to build a more credible audit trail than text alone. Moreover, these images are invitation to others to make their own judgments about my inferences and interpretations.

Video clips can also be used to corroborate and validate other data sources through the process of triangulation. In this case study, the selected video clips were triangulated with the scripts containing the students' original ideas, students' worksheet

Encouraging multiple points of view

Not only can video be viewed multiple times, it can be viewed from multiple points of view (Goldman-Segall, 1998). For example, some researchers might interpret participants' actions in the above exemplars as automatic and relatively thought-free. Certainly, if one takes the view that the built-in capacities of video technology and software do not necessarily require anything beyond simple manipulation or trial and error, this interpretation would be valid.

On the other hand, it is my belief that student's choices and use of video technology's built-in operations went beyond mere thoughtless manipulation to conscious awareness of how the chosen semiotic resources contributed to the overall meaning of their final videos. In this video clip, Lenny is discussing the



idea of changing the colors of the imagery in his bullying video from their overly “vibrant” hues to something darker. He chooses black and white tones to signify the seriousness of his public service announcement on bullying. From his statements and actions, it appears that Lenny is thinking deeply about how he can modify the final look and impact of his video.

Using video for self-reflection purposes

Another benefit of video is that it enables those who are videotaped to “view themselves and think about their actions” (Tochon, 2007, p. 9). Video has the capacity to prompt participants’ recall and reflection on their thoughts, feelings, or actions. Participants who watched the documentary videos that I made of them during their video creation projects were reminded of aspects of the process they had forgotten, (Catherine: “I didn’t realize how much it [our ideas] changed until I’m watching this now”) or came to new realizations about themselves (Tessie: “It verifies what a lot of people say about me cause I don’t get it...but now you see yourself on a video, oh I get it”) or reinforced ideas they already had about themselves (Kyle: “I believe my thinking is effective”).

In some cases, these documentary videos prompted the reoccurrence of sentiments that students had experienced during the process of creating or showcasing their videos. Commenting on how hard he had worked to complete the video project, JR expresses his feelings both verbally and nonverbally (leaning forward with earnest intensity in his voice): “Really bad luck, I had computer failure after computer failure”. He is visibly and affectively concerned about his reputation as a highly skilled video maker.

Sharing the video with others

Heath, Hindmarsh, and Luff (2010) noted that video also allows the researcher to show and share the data and findings with others thereby opening the interpretation up to public scrutiny. Exposing the data to others not only offers a means for building rigor and validity into one’s interpretations and findings (Pirie, 1996), but is also a way of co-constructing new knowledge.

Based on their particular viewpoints and beliefs, others will see things that I did not, thereby adding to the richness and depth of knowledge that is possible when using video as a research tool. The “lateral inquiries” or interpretations that emerge may change over time, with repeated viewings and new viewings (Goldman-Segall, 1998, p. 39) resulting in an ongoing construction of new knowledge and ideas about different aspects of the learning process made possible by using video as a research tool.

Challenges of Using Video during Data Interpretation

Interpreting video data

Since knowledge in video is constructed, interpretations of its meanings often resist quantification. Reading video and making meaning of it is the most challenging part of the research process. According to Nicholson (1999), researchers’ interpretations are “constructions of the constructions of the participants” (p. 19). I constructed my own representation of students’ metacognitive thinking and skills through my video recordings, choice of clips, coding, and analyses. Moreover, my inferences regarding students’ thinking about their thinking were based on my own subjective interpretations of the data and literature on metacognition. Still, as Peshkin (1988) has implied, it is often a researcher’s

subjective interpretations of events that make a unique contribution to the field of qualitative research and knowledge creation.

Due to infinite possibilities for combining “narrative, visual and aural” modes as well as the underlying semiotics beneath their surfaces (Dannenbaum, Hodge, & Mayer, 2003, p. 118), video creation expands the opportunities for knowledge construction, meaning making, and interpretation. The kinds of meanings derived from video differ qualitatively from other media or text. It is therefore important to play with the data, examining it from different perspectives in order to realize new insights or understandings.

Conclusion

The content for this article was derived from a multiple case study in which digital video was used to observe and document students’ thinking while they were in the process of creating videos for school assignments. In it, I explored the idea that the original work done by students in their scripts, video shoots, and preliminary edits was cognitive in nature while their feelings, thoughts, actions, discussions, and nonverbal reactions to this work were examples of metacognition.

DV was ideal for capturing different close-up views of each case, thus exposing what each participant was doing or felt was important. The resulting video data was corroborated by and triangulated with students’ artifacts, field notes and transcripts, and other school documents, resulting in thick descriptions, necessary for contributing to the corpus of knowledge about students’ metacognitive thinking during video creation.

These thick descriptions, allowed me to reiterate what others have found, i.e., that “video is an epistemological tool... for displaying the learners’ ways of thinking as they engage in learning” (Goldman, 2007, p. 32). In-depth examinations of the observation videos of each of the participants enhanced my understanding of their knowledge about themselves, their learning processes, their prior knowledge of video production and their chosen topics, and their abilities to engage in planning, monitoring, control, evaluation, and reflection during the different stages of video creation. This led to the formulation of partial insights on how video, as a visual research tool, can be used to reveal students’ metacognitive thinking and learning processes in naturalistic environments.

Using video as a research tool offers unlimited opportunities to delve into the complex, multifaceted aspects of what is being portrayed on the screen for the purpose of generating findings and multiple interpretations into students’ thinking, feelings, and embodied performances. On the other hand, it also comes with challenges, the most significant being the overwhelming amount of data that must be analyzed and interpreted. Without clear objectives or a theoretical framework, analysis and interpretation of video imagery is extremely difficult.

Video is also a technology through which new knowledge is constructed. It is a representation of “how we understand the meaning of concepts” (Hall, 1997, p. 17). Students, within the study, represented their knowledge, ideas, and thinking about certain topics through their videos. They also represented the different ways of interpreting those ideas through their choices of modalities, semiotic resources, and combination of these components in their final products. At the same time, I was also constructing knowledge about what I believed were their metacognitive and self-regulatory thoughts, feelings, and actions/interactions through my viewing, selection, clipping, coding, and interpretations of exemplar segments.

In conclusion, using video in this manner, as a research tool for gathering, analyzing, and interpreting data resulted in the construction of partial insights and findings that might have application in similar learning contexts. These insights could also form the basis for

further research in this area as well as lead to new theories on using video creation or other digital representational forms as a means to explore students' metacognition.

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Author Note

Rose E. Bene is an award winning educator and media producer who has worked in the area of educational media design for over thirty years. She is particularly interested in understanding how technologies such as digital video (DV) impact student learning and if DV can be used as a strategy for eliciting or promoting metacognitive thinking. Currently the

Director of Continuing Medical Education and Professional Development at the University of Calgary, Rose works with a team of educational consultants and logistics experts to design and deliver high quality courses and learning opportunities for healthcare professionals.

Correspondence for this manuscript should be addressed to Rose E. Bene at rebene@telusplanet.net or rebene@ucalgary.ca

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