The development of critical thinking skills using a Web-based video analysis system

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Abstract:

Our Web environment's tools for video analysis and writing afford a series of activities designed to promote critical thinking. Students analyze videos by selecting and annotating brief segments they can later use as evidence to support claims they make in an essay. In addition to the educational objective of making students more adept observers and interpreters of the content, a high-level goal of these activities is to help students adopt what the critical thinking literature terms an "evaluativist" approach to knowledge, meaning that students construct their understanding by evaluating and interpreting the evidence before them, developing personal theories, and taking in to account opposing standpoints and knowledge (Kuhn, 1999). We measure students' development of these skills by their use of the components of an informal argument: a central claim and supporting evidence, relational statements to connect evidence to claims, and reflective statements to mark the boundaries of their knowledge, acknowledge alternative interpretations, and suggest possible methods for obtaining needed evidence. Preliminary results show that students create increasingly sophisticated argument structures and begin to show signs of an evaluativist approach to the material.

Introduction:

We have heard how a course in the development of mathematical thinking led to the development of a pedagogical approach to engaging students with video in the classroom, and later online through the creation of a unique Web-based system called VITAL: Video Interactions for Teaching and Learning. Both of these talks have shown how the use of video for teaching is not nearly as simple as cueing the tape and letting it

play. Rather, video is most powerful as a learning tool when closely managed by the viewers, who transform the experience from passive to active, and the content from a simple broadcast to both an interactive manipulative and an object of study and debate. The subject of this talk is how students' use of video in VITAL contributes to the development of critical thinking skills.

The first talk described the faculty member's role in the process: selecting segments that are not only illustrative of particular topics or phenomena, but also lend themselves to questioning and interpretation. This approach offers students the opportunity to discover knowledge in a guided way, and also challenges them to formalize their interpretations and either defend or revise them in light of opposing viewpoints and subsequent viewings of the evidence preserved in the videos.

The second talk described VITAL, the Web-based system created by Professor Herbert Ginsburg of Teachers College and the Columbia Center for New Media Teaching and Learning to capture the important features of these classroom interactions and offer students a means to practice their skills of observation, interpretation, and argument. The pre-selection of videos and the structuring of what we call "guided lessons" give students an opportunity to develop practical skills for assessing children in the classroom, such as observation and clinical interviewing.

We believe that skillful observation and interpretation are at the root of quality teaching. To teach children well, one must understand their thinking, and ongoing observation and interpretation are tools of formative assessment that provide the teacher with a steady, if informal, source of information about what her children truly understand. This method can be more helpful for enhancing teaching practice than formal testing

because the former focuses directly on children's experience as learners, whereas the latter samples behavior only occasionally and usually fails to provide useful feedback to the teacher. Observation and interpretation also contribute to teachers' ability to become more sensitive and responsive to the enormous amount of information they gather from everyday interactions with children, which may otherwise resemble William James' "blooming, buzzing confusion" (1890, p. 462).

Observation and interpretation skills also constitute an important part of the critical thinking process. While VITAL was created specifically to offer access to video content and learning activities exhibited in naturalistic observation and clinical interviewing, we have discovered that students who use VITAL in this course develop more sophisticated approaches both to the content and to argument writing. While we cannot currently isolate the effects of VITAL from the impact of participation in the course, we hypothesize that the unique affordances of VITAL—a visual space for collecting video-based evidence that can be cited directly in essays—help students organize their thinking and construct stronger, more reflective arguments.

We measure critical thinking skills according to students' use of the components of an informal argument: a central claim and supporting evidence, relational statements to connect evidence to claims, and reflective statements to mark the boundaries of their knowledge, account for competing claims, and suggest possible approaches to obtaining needed evidence (Billig, 1987; Kuhn, 1991; Glassner, 2005). Many students use an approach similar to "theoretical sampling" (Strauss & Corbin, 1990) in which they operate from an existing theory based on readings or their own experiences with children, and revise their thinking as they test their claims against the videos. What we hope to

instill in students is sensitivity to the evidence that encourages them to be deliberate in validating what they see and in explaining the connections between their evidence and claims. Ideally, students will also entertain new, alternative claims when the evidence points to other possible interpretations. Finally, we hope they will acknowledge the boundary between what they know and what they must investigate further, and perhaps suggest a method for doing so. Unfortunately, an empirical approach of this type is often lacking in some educational perspectives, even at the professional level.

Methods:

Our subjects were 20 early childhood teacher candidates (herein referred to as "students") enrolled in Prof. Ginsburg's development of mathematical thinking course at Teachers College in fall 2006. These students each composed five short essays (each approximately 350 words) over a two-month period. The essays were written on the following topics related to the psychology of mathematics in the early grades: mathematics all around us, everyday number, addition and subtraction, geometry, and algebra and pattern. Students were required to complete a few short readings on each topic and watch one to three videos that illustrated the content in some way, typically with a child completing a mathematical task and answering questions posed by an adult researcher. The essay questions were brief and always concluded with the request, "Please discuss using evidence from the videos and readings in 350 words or fewer." Students used the VITAL video viewer to select clips from the assigned video(s), and then they composed an essay in the VITAL assignment space, where they integrated the video clips into their text.

We developed a method of coding the essays that took into account the basic components of informal argument, claim and evidence, as well as statements that attempt to explain the connection between the two ("relation"). The three elements—claim, evidence, and relation—constituted a single unit of argument. Units contained only one claim, but there could be multiple instances of evidence and multiple instances of relation.

Relational statements could correspond one-to-one to the evidence, or a single piece of evidence could have several relational statements, such as when students were considering multiple interpretations of a single observation. This latter condition represented the most advanced form of argument writing, because it contained alternative interpretations of the evidence.

After an initial pass at coding the data, we added a fourth element: "reflection." Students who consistently use reflection exhibit the qualities of the "evaluativist" (Kuhn, 1991), critically examining the relative merits of claims based on available evidence. Reflective statements acknowledge of the limits of a particular claim, supporting evidence, or the certainty with which interpretations can be made, and take opposing claims into account (Finocchiaro, 2003; Glassner & Schwarz, 2005). Students in this category may also suggest means of obtaining more information.

Each element in the coding system has two levels:

(1) Claim: a statement of belief, an assertion, or a generalization about children, learning, etc.

- Reasonable – claim makes sense in context
- Unreasonable – claim seems too broad to justify in essay, or in general

(2) Evidence: a reference to or description of observable events, usually positioned to support the relevant claim

- Valid reading of evidentiary content – the content is or shows what the student says
- Invalid reading of evidentiary content – the content is not or does not show what the student says

(3) Relation: an explanation of how the selected evidence connects the claim (either supporting or contradicting)

- Explicit relational statement – relationship between claim and evidence is deliberately explained by the student
- Implicit relational statement – relationship between claim and evidence is implied

(4) Reflection: given the above, evaluating the adequacy of a claim and proposing alternatives, and/or acknowledging the limits of the evidence (and perhaps suggesting a method for obtaining it)

- Conditional – evidence may account for claim, or may support other possible claims
- Conclusive – evidence fully accounts for claim

An application of this coding scheme to student essays is discussed below.

Results:

Research suggests that a "cognitively rich environment" can help students develop skills of argument without direct instruction in these skills (Kuhn, 2001a; Kuhn, Shaw, & Felton, 1997). A review of our data suggests that students using VITAL in this course improved their argument writing based on the criteria listed above.

One way to look at the data is in terms of a simple count of the first three elements: claims, evidence, and relational statements. The goal was to determine how student use of these three elements changed over time. The author also counted the number of video clips placed in each essay to assess whether students became more comfortable with the VITAL video clipping and embedding functions. In the data

presented in Figure 1, the amount of evidence used in essays between the first and the fifth stayed relatively constant; what is interesting is the declining ratio of claims to evidence; by the fifth essay, students became more modest in their use of claims and more likely to use multiple pieces of evidence to support them. This implies that students became more thoughtful and more careful in their interpretations over time, and that further examination of the data is promising.

Figure 1: data from simple counts

Essay 1

	claim	evidence	video	relation
sum	176.00	161.00	80.00	28.00
x	8.80	8.05	4.00	1.40
s	2.53	3.55	3.26	1.88
v	6.38	12.58	10.63	3.52

Essay 5

	claim	evidence	video	relation
sum	54.00	141.00	128.00	130.00
x	2.70	7.05	6.40	6.50
s	1.56	1.19	1.05	1.88
v	2.43	1.42	1.09	3.53

As a result, the author has probed more deeply into the data, examining claims, evidence, and the relationship between them, as well as reflective statements, which appear as a meta-level critique of a completed unit of argument. The best student writing included this kind of statement as an assessment of the adequacy of the various elements, using conditional language to convey uncertainty, and occasionally suggesting methods for obtaining needed evidence, such as specific tasks or questions to present to the child.

The following example is an excerpt from the first essay a student completed for the course. The assignment was to identify examples of mathematical thinking in a video of two boys, Armando and Keithly, engaged in block play (and rich conversation). Boxed text with time codes represents the video clips embedded in the essay by the student and viewable in VITAL.

> [The article]'s broader look at geometric concepts allows one to notice the possible geometric perceptions that Armando and Keithly are involved in (in addition to playing with shape solids Shapes 0:00:11-0:00:16). When a child moves the blocks around and places them at different spots, he is exploring the fundamental spatial relations that are concepts of "topology." In this clip, as the boys adjust the blocks to build the next layer of their structure, they deal with proximity and "nearness". Measurement 0:00:32-0:00:45 The clip also shows their understanding of length and measurement as the boys realize that the two bases are too far apart: the long block "could not reach" from one base to the other. They follow a pattern by lining the blocks one next to another lengthwise. Pattern making 0:00:47-0:01:00 Another aspect of measurement demonstrated by Armando and Keithly is in *comparing* block sizes. Comparison 0:02:48-0:03:02 Additionally, their talking about "something under there" and putting people *under* their structure shows different perceptions of space. Topology? 0:01:02-0:01:09 Topology?1 0:02:02-0:02:19

Now the same essay excerpt, color-coded to distinguish among the different elements. Yellow signifies claim, green is evidence, blue is relation, and pink is reflection.

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bases are too far apart: the long block "could not reach" from one base to the other. They follow a pattern by lining the blocks one next to another lengthwise. Pattern making 0:00:47-0:01:00 Another aspect of measurement demonstrated by Armando and Keithly is in *comparing* block sizes. Comparison 0:02:48-0:03:02 Additionally, their talking about "something under there" and putting people *under* their structure shows different perceptions of space. Topology? 0:01:02-0:01:09 Topology?1 0:02:02-0:02:19

In this example, three of the four elements of argument are present. The excerpt contains many pairings of claims and evidence, but they are loosely associated—their relationships are either implied or explained indirectly, without carefully tying the evidence back to the claim. Notably, there are no instances of reflective language; the student is certain that her interpretations are correct.

The next excerpt is from another student's fifth essay. The assignment is to responds to a video of a child, Gabriella, age 3.5, who has been asked to extend a pattern consisting of alternating blue and green bears. In the video, the interviewer asks her to select the next color, which should be green, but Gabriella picks blue. When asked about her choice, she changes her choice to green. The student writes:

> It seems as if Gabriella contradicts what she knows about patterns throughout her interview. When asked what color comes next in a blue-green pattern, she puts a blue, the wrong color in the sequence.
> Blue 0:00:33-0:00:37 At this point, it would seem that although Gabriella does not understand that there is a specific relationship between green and blue bears, she knows that the choice is either blue or green, which is further confirmed when she "corrects" herself and changes the blue bear to a green one— although I think that the interviewer misinterpreted Gabriella saying that "you (the interviewer) put green".
> Explanation of why blue 0:00:55-0:01:09
> She pairs the green up with a yellow bear, so although she might be forming an idea of the "unit", she does not understand that a pattern repeats or that the fundamental unit of this pattern does not change. Her explanation of this further demonstrates her confusion.
> Explanation of Yellow Bear 0:01:32-0:01:40

Now the essay excerpt color-coded to distinguish among the different elements. Once again, yellow is claim, green is evidence, blue is relation, and pink is reflection.

> It seems as if Gabriella contradicts what she knows about patterns throughout her interview. When asked what color comes next in a blue-green pattern, she puts a blue, the wrong color in the sequence.
> Blue 0:00:33-0:00:37
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The structure of this excerpt is claim, three pieces of evidence (sometimes the text version of the evidence is not contiguous to the video version of the same content), and one or more relational statements *per piece of evidence*. The excerpt begins with a single claim: "Gabriella contradicts what she knows about pattern." The three pieces of evidence include: (1) Gabriella's incorrect selection of a blue bear, (2) correcting her answer to green, and (3) her incorrect selection of a yellow bear next. For each instance of evidence, the student provides at least one relational statement, and sometimes more. For example, she offers two possible interpretations of Gabriella's confusion over blue versus green. It is unclear whether Gabriella understands there is a repeating unit. She does, however, appear to know that there are only two colors to choose from. The student also offers a critique of the interviewer, implying that another clarifying question to Gabriella would have been helpful. The student uses reflective language throughout; the

conditional phrases such as “it seems” and “she might,” and her use of “at this point” connote that there are limits to what can be concluded given the currently available evidence. Indeed, by the end of the clip, Gabriella’s behavior suggests that she does not in fact understand the premise of the repeating pattern.

Consider now a detailed illustration of each element and level with examples from the students’ work, with contrasting examples provided.

(1) Claim: a statement of belief, an assertion, or a generalization about children, learning, etc.

- *Reasonable – claim makes sense in context*

  Gabriella contradicts what she knows about patterns throughout her interview.

  This claim is confined to the specific instance at hand and can be supported with evidence from the available video.

- *Unreasonable – claim seems too broad to justify in essay, or in general*

  Children’s understanding of patterns lays the foundation for later algebraic thinking.

  This claim may be valid, but it is too general to be supported in the context of a short essay, with the available video.

(2) Evidence: a reference to or description of observable events, usually positioned to support the relevant claim

- *Valid reading of evidentiary content – the content is or shows what the student says*

  … she “corrects” herself and changes the blue bear to a green one

  The child does in fact change her mind in a way that is consistent with a person correcting herself. Adding the quotation marks is appropriate because

we do not know for sure whether the child is actually correcting her first response or just making another available choice.

- *Invalid reading of evidentiary content – the content is not or does not show what the student says*

  … she sees that she has broken the pattern and changes the blue bear to a green one

  The video contains no evidence to suggest that the child recognizes that her choice has interrupted the one she is working with.

(3) Relation: an explanation of how the selected evidence connects the claim (either supporting or contradicting)

- *Explicit relational statement – relationship between claim and evidence is deliberately explained by the student*

  Claim:

  Gabriella contradicts what she knows about patterns throughout her interview.

Evidence:	Relation:
… she puts a blue, the wrong color in the sequence. Blue 0:00:33-0:00:37	… Gabriella does not understand that there is a specific relationship between green and blue bears
she "corrects" herself and changes the blue bear to a green one Explanation of why blue 0:00:55-0:01:09	… she knows that the choice is either blue or green
pairs the green up with a yellow bear Explanation of Yellow Bear 0:01:32-0:01:4	… she does not understand that a pattern repeats or that the fundamental unit of this pattern does not change

This example is particularly illustrative of the inadequacy of the first coding scheme because all three instances of evidence are required in order to validate the claim that Gabriella's understanding of pattern can be self-

contradictory. The sequence of conclusions drawn from the child's behavior is wrong-right-wrong, and the relational statements accompany each one, together tying the evidence back to the central claim.

- *Implicit relational statement – relationship between claim and evidence is implied*

  Explanation of Yellow Bear 0:01:32-0:01:4 Her explanation of this further demonstrates her confusion

  The relational statement (on the right, in blue) does not make a clear connection to the preceding claim. The use of words like "shows" and "demonstrates" without any further discussion indicate that the student sees a connection, but the relation still needs to be articulated.

(4) Reflection: given the above, evaluating the adequacy of a claim and proposing alternatives, and/or acknowledging the limits of the evidence (and perhaps suggesting a method for obtaining it)

- *Conditional – evidence may account for claim, or may support other possible claims*

  At this point, it would seem that although Gabriella does not understand that there is a specific relationship between green and blue bears, she knows that the choice is either blue or green

  The use of reflective language in here is conditional and cognizant of the limits of what can be concluded given the available evidence. The use of "at this point" qualifies a reasonable interpretation—the child understands the limiting of the pattern to the colors green and blue, but not the relationship between them—leaving open the possibility that later evidence may prove either or both of these statements to be incorrect.

- *Conclusive – evidence fully accounts for claim*

  … she does not understand that a pattern repeats or that the fundamental unit of this pattern does not change

  The statement does not include conditional language. It also closes off the possibility that subsequent questions to the child would not yield a different result, which is not necessarily a safe bet.

Discussion:

Our next step will be to apply our coding scheme to a large number of essays. We hope to discover the point at which, in their use of VITAL, students' argument writing skills improve, and to describe what this evolution looks like. The study will examine changes in students' organization of claims and evidence, the nature of relational statements, and students' developing use of reflective statements as they progress to a more evaluativist approach to the material when using VITAL.

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