Video-Based Exercises for Developing Early Childhood Educators' Use of Evidence and Interpretation

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Paper Presented at Symposium "A Video-Based Pedagogy for Improving College Students' Understanding of Development and Education"
SRCD 2009 Biennial Meeting, Denver, CO
April 3, 2009

Abstract

Students who use a unique Web-based video analysis system in a course on early childhood mathematics education not only learn the relevant content, but they also improve their skills of argument. Specifically, they learn to make more judicious claims, cite more evidence relative to the number of claims, and make explicit connections between their claims and evidence. In addition, some students also develop a sort of "intellectual humility" with regard to the certainty of their claims and the need for more information. These results suggest a relationship between learning in the course, including regular practice with the video analysis, and the quality of students' interpretation and argument writing.

Background

Skillful observation and interpretation are important components of quality teaching. To teach children well, one must understand their thinking, and ongoing observation and interpretation are tools of formative assessment that provide teachers with a steady, if informal, source of information about what their 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). They may even help equip teachers for a

vocation that is as much art as it is science, if not the exact intersection of the two (James, 1899, p. 7-8). No one denies that teachers must be well prepared, but the difficult part is to prepare them to make the numerous "subtle judgments and agonizing decisions" (Shulman, 1992, p. 20) they constantly face.

Observation is more than the act of seeing something. It involves training an "enlightened eye" (Eisner, 1998) on the important aspects of behavior while also applying knowledge of the relevant content (Dewey), working with an understanding of psychological theory about children and learning (Piaget), and perhaps also maintaining a safe distance from preconceptions and prejudices. Many factors contribute to what one sees when observing children. Interpretation connotes a recognition of significant moments and offering a plausible explanation for their meaning, which may be grounded in prior learning or other experiences (Strauss & Shilony, 1994).

A working theory can be tested against observed evidence, using argument skills to evaluate theory against evidence, and to revise ideas about what a child may or may not understand, or generate new alternative hypotheses that may also be tested. Argument is defined as the coordination of claims and evidence—a critical approach to the information one has gathered (Billig, 1987; Kuhn, 1991; Glassner, 2005). Arguments may also contain relational statements to connect evidence to claims. More robust arguments also account for competing claims. Additionally, an important characteristic of high-quality arguments is parsimony; offering the "minimum interpretation possible" demonstrates a respect for evidence and epistemological uncertainty: to make additional claims, one may have to gather more evidence.

It is possible to hone each of these skills through specific experiences, particularly through the use of technologies that provide frequent, controlled opportunities to observe and interpret children's behavior in order to substantiate theories about how children think and should be taught. The goal of these exercises is to help student teachers (hereafter "students") integrate their formal training with personal experience, to help connect the theoretical with the concrete, and also to prepare them to apply these skills in their own classrooms. An added benefit should be helping teachers become reflective about their work and more likely to confront their preexisting beliefs about children and teaching.

Research suggests that a "cognitively rich environment" can aid in the development of the skills of argument (Kuhn, 2001a; Kuhn, Shaw, & Felton, 1997). This study focuses on a method of close analysis of video that is designed to help students better understand and practice the observation of children, interpret their actions, and develop reasonable theories to explain the children's behavior in order to further guide teaching—and to devise additional questions and new tasks for further testing. This process represents a recursive, iterative response to new events; gathering more information creates the need for new evidence. By practicing these activities in a controlled setting, students can prepare for classroom-based formative assessment.

The goal of this method is to instill in students 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, and they

will learn to acknowledge the boundary between what they know and what they must investigate further, and perhaps suggest a method for doing so.

This work has a number of implications for teacher development: first, it grounds teachers' learning in the empirical, and second, it offers them the opportunity to practice their skills of observation, interpretation, and reasoning in preparation for entering the classroom.

A system for video analysis and interpretation

This study focuses on students' use of a Web-based video analysis system called "Video Interactions for Teaching and Learning" (VITAL), developed by the Columbia Center for New Media Teaching and Learning. The system provides students with ready access to a library of online video along with a set of tools for video analysis designed to help students practice and refine their skills of close viewing, interpretation, and coordination of claims and evidence.

VITAL was originally created for "The Development of Mathematical Thinking" at Teachers College, a graduate level course on early childhood mathematics education. The students in this course are typically working toward certification in early childhood education (birth through age 8). The course covers topics recommended by NCTM including number and operations, geometry, measurement, algebra (including patterns), and data analysis (NCTM & NAEYC, 2002). Beyond the mathematics education content, an important goal of this course is to prepare teachers who can use multiple sources of knowledge to make valid professional judgments and decisions regarding early mathematics education in their classrooms—what to teach, when to teach it, and how best to teach it (Ginsburg, Jang, Preston, VanEsselstyn, & Appel, 2004). Students in the

course use VITAL regularly to view videotaped examples of children engaging in mathematical activities, and to complete analytical assignments that require them to interpret the videos and develop and defend hypotheses about children's mathematical thinking and learning.

A course "home" page in VITAL looks like a conventional syllabus, with a list of topics, readings, and assignments, but it also includes a selection of videos for each topic that can be viewed by clicking on the links embedded in the page. (See Fig. 1.) Because the full course library includes more than 100 videos, the careful selection of videos for each topic in the syllabus is critical, particularly when choosing videos for the assignment that students will complete.

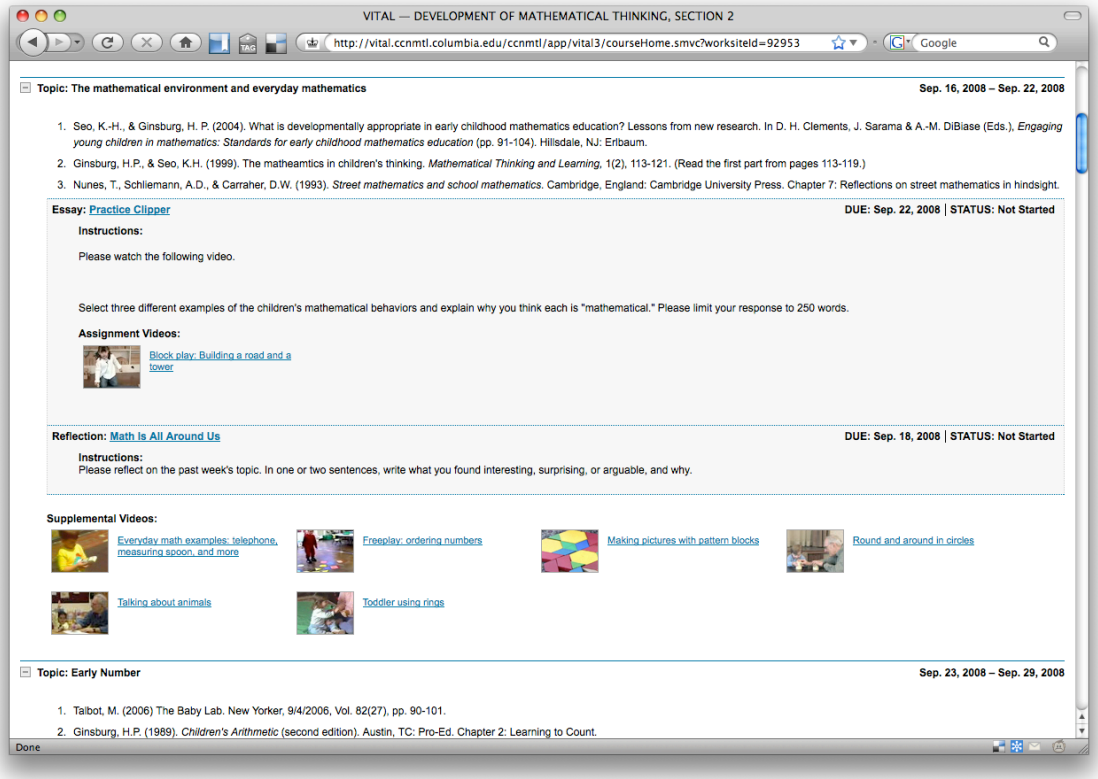

Fig. 1: A single week's topic from the syllabus in VITAL, including an assignment with one required video, followed by six recommended videos.

VITAL offers several affordances that enable students to work with video at home via the Web. The first feature is a "video viewer" in which students can select and clip their own segments from the videos, and attach a note to each clip to help them remember the significance of the content. (See Fig. 2.) These clips and notes are saved in a personal workspace, where they can be accessed later and used to support an essay.

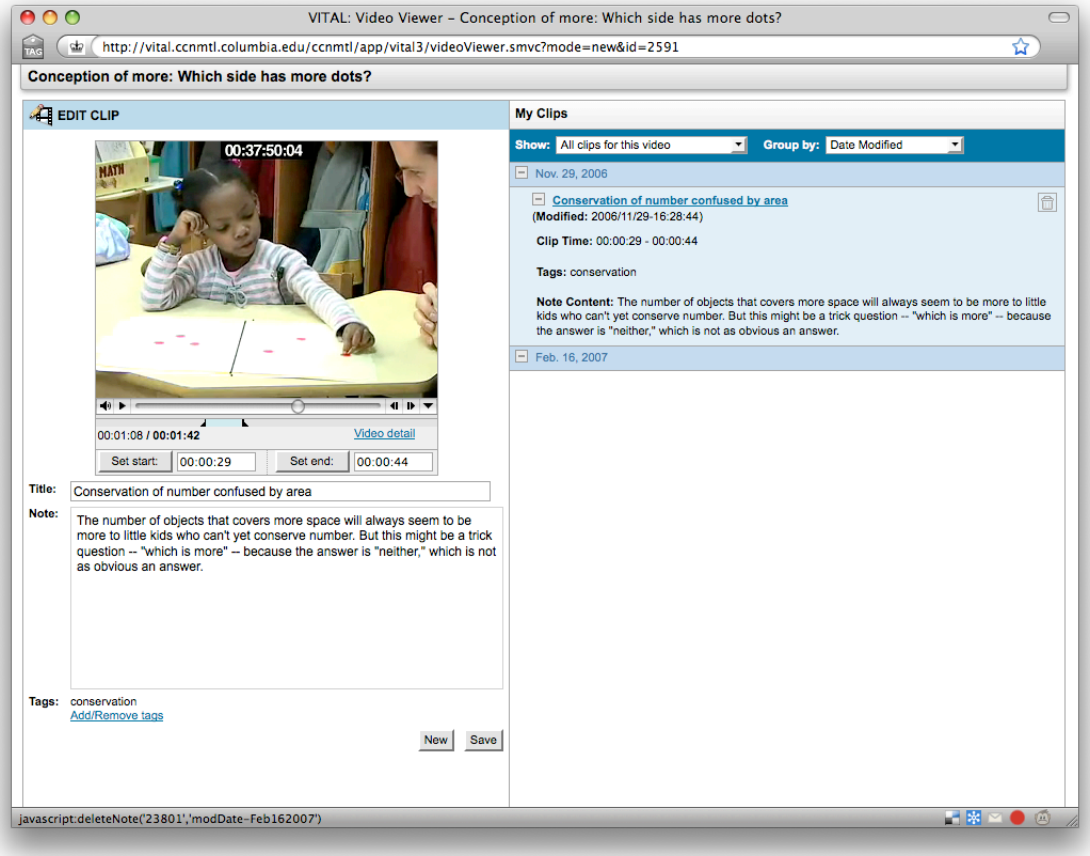

Fig. 2: The VITAL video viewer, with editing tools and an annotation space beneath the video, and clips with notes collected in the right-hand column.

The second feature is a "multimedia essay" space where students can integrate their clips with text. (See Fig. 3.) In the course, students are asked to write essays of 350 words or fewer in response to questions such as, "What do the children know about number? Please cite from the videos and the readings." These assignments encourage

students to develop their own hypotheses and select evidence from the course material that supports their argument. Completed essays are "published" within the VITAL environment to be read by the instructor and other students. The instructor can also leave feedback for the student.

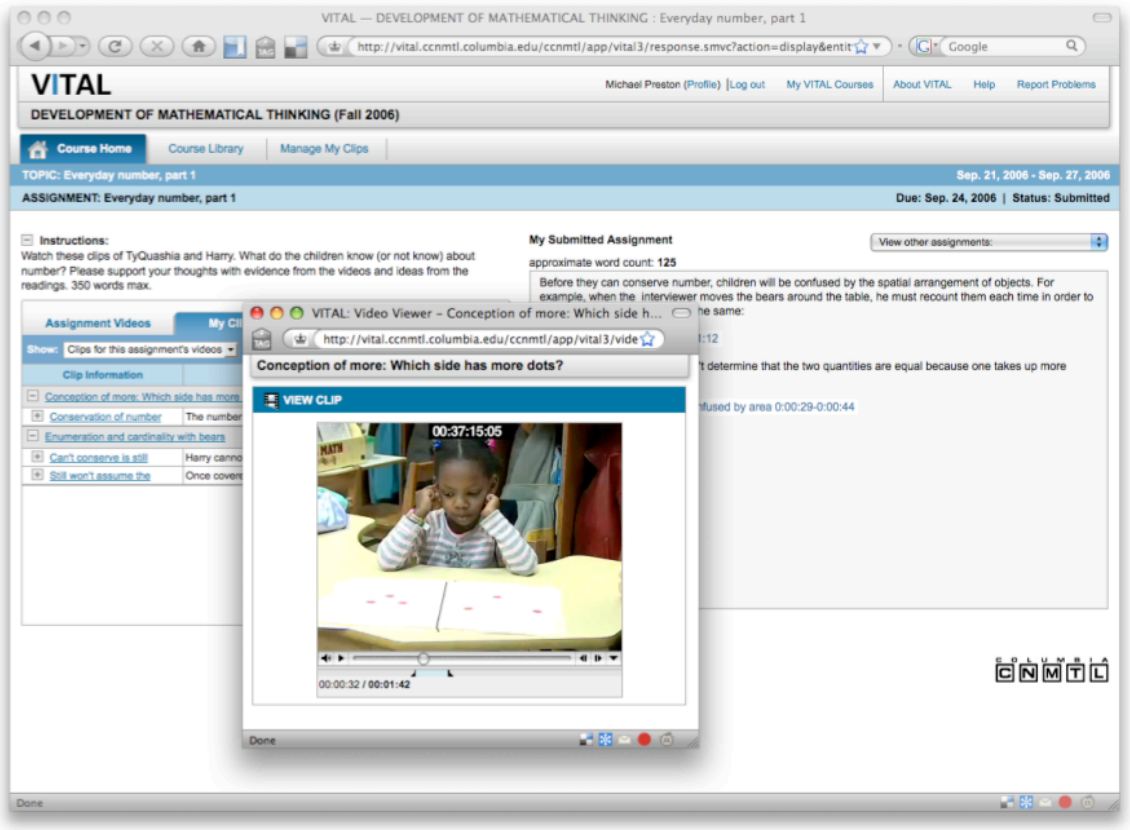

Fig. 3: The multimedia essay, with the student's collected video clips on the left side of the screen, and a writing space incorporating text and video on the right. Students click or drag their video clips to add them to their essay.

In addition to essays, students complete a series of "guided lessons" in clinical interviewing. These assignments are designed to simulate an interview by stepping students through videotaped interviews and prompting them to interpret the child's behavior and the interviewer's technique, to anticipate what the child will do next, and to make recommendations for subsequent questions.

Students also write a weekly reflection in VITAL within 24 hours of class, which is the concluding event for the week and serves as an opportunity to express what they learned, pose questions, and dispute ideas discussed in class.

In the final month of the course, students complete a project that involves designing a mathematical lesson or activity, trying it out with a child, and interviewing the child afterward to find out what he or she learned. The student records these events on videotape, submits the tape for inclusion in the VITAL library, and writes a research paper, in the form of an extended multimedia essay, that details the literature, methods employed, and results obtained. The final project integrates the mathematics content learned in the course with the assessment skills associated with clinical interviewing. The final project report submitted in VITAL also serves as a demonstration of the students' ability to think critically—even scientifically—about the work they are doing as teachers and what a child might be learning as a result.

In brief, VITAL introduces a sequence of activities—essays, lessons, reflections, an interview, and a final project—that are designed to help students learn to observe, make hypotheses, evaluate interpretations in the light of evidence, use a clinical interview to investigate, and apply their ideas and skills to teaching.

An empirical approach to assessing argument skills

The various elements of the course, particularly classroom interactions around videos and VITAL assignments, were designed to promote and support reflective thinking as described earlier: observe, interpret, investigate, and apply. By providing students with opportunities to independently apply their developing skills of observation and interpretation to the analysis of videotaped examples of children's behavior, VITAL

creates the possibility for individual students to develop personally meaningful working theories of student behavior, to learn to observe behavior through the enlightened eye and to investigate thinking with the clinical interview, and finally to apply the working theories and investigative techniques to issues of instruction.

To evaluate the success of this approach, one evaluation study (Preston, 2008) examined the process of student interpretation by focusing on open-ended assignments in which students were required to identify important moments in a video and interpret them. A typical student essay would include several references to specific video clips, an interpretation of what was happening in each clip, and student-generated hypotheses about what the child might be thinking. For example, one student wrote:

> 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

This particular excerpt contains claims, evidence, and one or more "relational statements" or reasoning linking the evidence to the claims. 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, but she appears to understand 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 modest 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.

This exploratory process yielded a full list of categories including claims, evidence, relational statements, modest statements, and references to literature. Consider each in turn.

Claims

A claim is a generalization, a statement of belief, or an assertion (about children, learning, etc.). It can also be a prediction. A claim tends to introduce a new idea, e.g., "Children can count mentally or use a variety of other strategies." A claim tends to be broad and to require substantiation, e.g., "The boys demonstrate a strong understanding of spatial relations."

Evidence

Evidence is a reference to or description of observable events, usually positioned after a claim. In this study, evidence can appear as text (verbal description) or video

inserted within the essay. Evidence contains observable events that two people can more or less agree upon objectively, e.g., “Armando tries to add another block to connect the two structures, but it doesn’t reach.” Evidence can include both verbal and nonverbal behaviors, e.g., “Armando begins looking around for a certain block and says ‘circle thing’ to describe it.” There is an interpretive component in the naming and placement of a clip, but any deliberate attempt to use evidence to support a claim constitutes a “relational statement” (see below). Evidence refers exclusively to the naming or identifying of observable behaviors.

Relational statements

A relational statement offers an explanation/interpretation of how the selected evidence connects back to a claim. A relation interprets what is happening in the cited evidence, e.g., “Armando’s use of the phrase ‘circle thing’ demonstrates that he knows some shapes and can identify this aspect of the cylinder, even if he doesn’t have the proper word for it.” A relation explains how the evidence supports (or contradicts) a claim, e.g., “Gabriella appears to know what colors can be used in her blue-green pattern, but when she chooses yellow, it shows that she may be more focused on the colors than on the rules of patterns.” Relational keywords include “shows” and “demonstrates,” i.e., words the author uses to explain the evidence or to comment on something that is otherwise observational. Good relational writing might include more than one interpretation per piece of evidence.

Modest statements

Modest statements evaluate the adequacy of a claim, propose alternatives, or acknowledge the limits of the evidence. Modesty includes "intellectual humility" by which the author recognizes the limits of what is knowable given the evidence, e.g., "At this point it seems that the child understands the idea of pattern." Modest language includes explicit statements in which the author assesses the relative certainty of a specific interpretation, e.g., conditional words like "might" and "could" (anticipating other possible interpretations), perception words like "appears" and "seems" (limiting certainty), temporal words like "now" and "before" (acknowledging interpretations can change with new evidence), and metacognitive words like "we realize" and "leads one to believe" (inserting the author's thinking into the essay). Modesty can also identify missing evidence, e.g., "Because the interviewer changed tasks, we did not see whether Gabriella could continue the pattern on her own," as well as suggestions for obtaining more evidence, e.g., "I would have asked the child to make her own pattern to see whether she understood the repeating concept."

References to literature

A reference is a citation or actual quoted text from literature, which can be used in a variety of ways. References can be appeals to authority, used to add arbitrary certainty to a claim or relation, often where no evidence is cited. In this instance, reference substitutes for reasoning and evidence, which might be termed an "authoritarian" use of reference. For example, one student explained an episode not by referring to any evidence but simply by asserting what an authority wrote about children at that age level: "According to Ginsburg (p. 61), one of the strategies children use to count is by counting

the value of the larger set and adding one." References can also be used to provide a framework for justifying a claim. In this next instance, references provide support to the author's own reasoning and evidence, which might be termed an "authoritative" use of reference, e.g., "He used the strategy of counting on from the larger number (Ginsburg, p. 61)."

These five elements combine to represent a working definition of informal argument, consisting of a central claim and supporting evidence, and relational statements to connect evidence to claims (Billig, 1987; Kuhn, 1991; Glassner, 2005). More robust arguments also account for competing claims (Finocchiaro, 2003; Glassner & Schwarz, 2005), and thus exhibit a kind of "modesty," as well as efforts to identify needed evidence, and suggestions of methods for obtaining it. Additionally, an important characteristic of high-quality arguments is parsimony; offering the "minimum interpretation possible" demonstrates a respect for evidence and epistemological uncertainty. To make additional claims, one may have to gather more evidence. Students were not aware of any interest in these criteria, nor were they instructed explicitly in the skills of argument. The instructions for each essay focused primarily on the relevant content, although they did encourage students to cite evidence.

Regular practice in the analysis of video, in the context of short writing assignments requiring interpretation, should help students create and improve their use of informal arguments in a number of specific ways. Research questions include:

1. Do students learn to make more careful claims?
2. Do students learn to use more evidence to support their claims?
3. Do students learn to make more explicit connections between their claims and evidence?

4. Do students learn to be more "modest" either by qualifying their interpretations with conditional language or by stating what information is required to be more certain?
5. Do students cite from the literature in a way that supports their argument but does not serve as a substitute for evidence or reasoning?

This empirical study was designed to test these questions by developing appropriate measures of informal argument within the framework of video analysis. The subjects were 20 students enrolled in "The Development of Mathematical Thinking" in fall 2006. Every student in the course used VITAL to compose five "multimedia essays" of 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 interviewer. The essay questions were brief and always concluded with the request, "Please discuss using evidence from the videos and readings." Students used the VITAL video viewer to select clips from the assigned video(s), and then they composed an essay in the VITAL essay space, where they integrated the video clips into their text. After submitting their essays, the students received feedback from the course TAs and had an opportunity to discuss their interpretations in class, which took place two days after the essays were submitted.

The study examines the first (mathematics all around us), third (addition and subtraction), and fifth (algebra and pattern) essays to sample the students' development of argument skills as they progressed through the course. These essays are identified here

as Essay 1, Essay 2, and Essay 3 for purposes of this analysis. The study did not have the benefit of a control group to help disentangle the effects on students' argument skills of specific factors such as the use of videos in class, the content of the lectures and readings, preexisting inquiry skills, or the order in which assignments were presented to students.

Three independent reviewers coded the essays as illustrated above. The codes for each essay were summed and divided by the total number of sentences per essay in order to adjust for differences between longer and shorter essays. Inter-rater reliability for the variables were r=0.756 for claims, r=0.845 for evidence, r=0.541 for relational statements (which will be improved in a subsequent study by refining the coding definition and providing additional training to coders), and r=0.870 for modesty. A repeated measures one-way ANOVA was run for each coded variable—claims, evidence, relational statements, modesty, and references—and Tukey's HSD used to determine whether differences between the means were significant.

Results

The analyses show significant differences related to the main variables of concern: claims, relational statements, and modesty. The process also yielded a new variable, the ratio between claims and evidence, to reflect the significance of a decreased number of claims even when the number of pieces of evidence remained relatively constant.

Claims

The first research question was, "Do students learn to make more careful claims?" The hypothesis was the number of claims would decrease as students learned to use them

more judiciously. In this study, the average number of claims per sentence decreases significantly between essay 1 and essay 3, $F=16.472$, $df=2$, $p<.001$. (See Fig. 4.) The number of claims decreases significantly at the $p<.05$ level between each essay, and at the $p<.01$ level between essay 1 and essay 3. Three students' claims increase between essay 1 and essay 3.

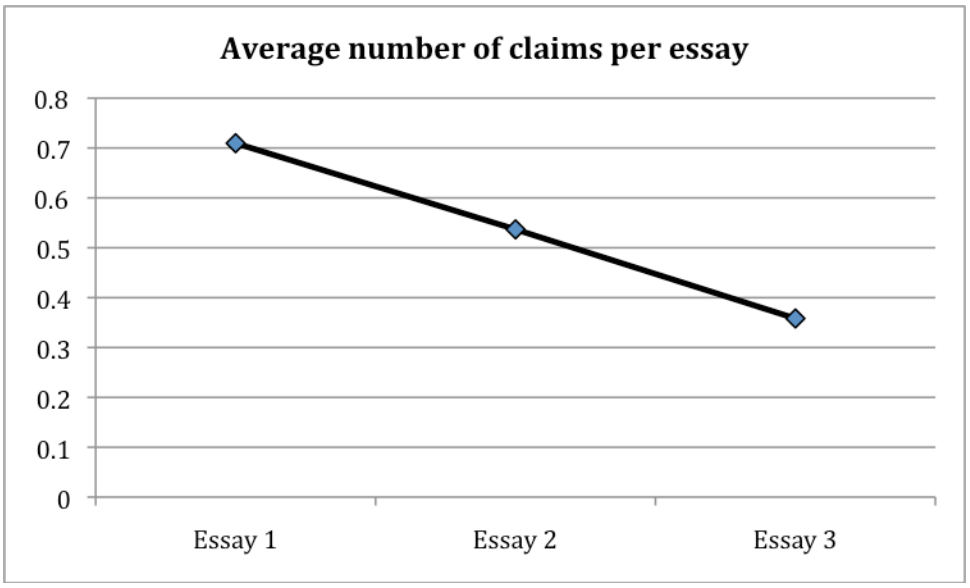

Fig. 4: Each data point represents the mean of the students' average number of claims in a given essay. The average was calculated by dividing the number of claims by the number of sentences in each essay.

It is possible that the nature of the video and assignment associated with essay 1 encourages a higher number of claims, since students were instructed to identify and explain examples of mathematical thinking in a less structured video clip, rather than to support a specific argument, as they were in essay 2 and essay 3. However, the mean continues to decrease significantly and at the same rate between essay 2 and essay 3 as between essay 1 and essay 2, which suggests the video and assignment types are not as important as might have been expected.

Evidence

The second research question was, "Do students learn to use more evidence to support their claims?" The hypothesis was the students would learn to use more evidence to support their claims. However, the number of instances of evidence stays relatively consistent across the three essays—there is no significant difference among the three means ($F=1.173$, $df=2$, $p=0.320$). Yet there is a simple explanation: as the number of claims decreases, the steady rate of evidence still represents an increase in the amount of evidence cited per claim. Here the *ratio* of claims to evidence seems to be a more valid measure, as students should use more evidence per claim as their work improves, or, putting it backwards, fewer claims per piece of evidence. This variable was also significant ($F=10.354$, $df=2$, $p<0.001$). (See Fig. 5.) The difference between the means of essay 1 and essay 2 is non-significant, but the difference between essay 1 and essay 3 is significant at $p<.01$, and between essay 2 and essay 3 at $p<.05$. Four students' claim-evidence ratios increase between essay 1 and essay 3.

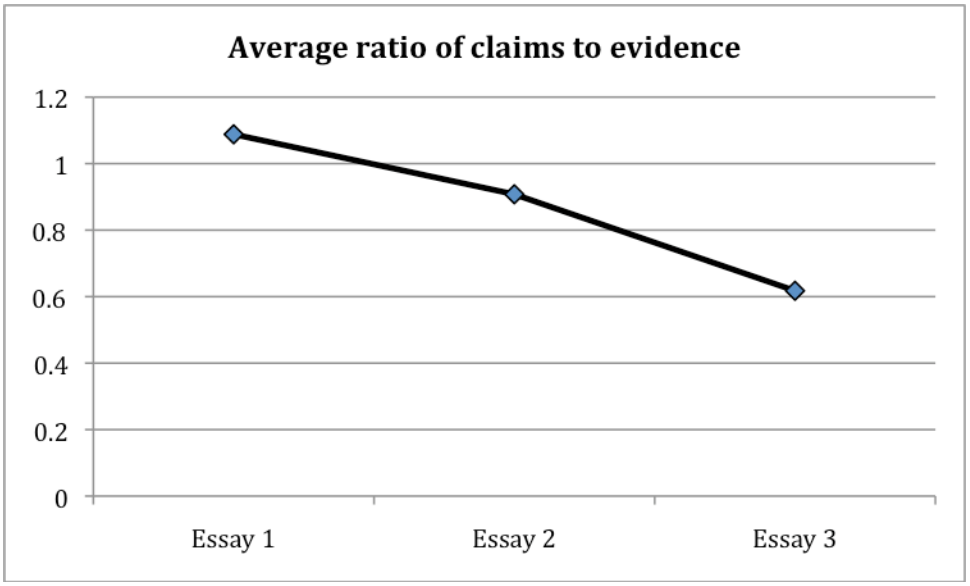

Fig. 5: Each data point represents the mean of the students' ratio of claims to evidence. The ratio was calculated by dividing the number of claims by the number of instances of evidence in each essay.

Even though the total number of instances of evidence does not change significantly, it is worth noting that students gradually shift from using text-based to video-based evidence, which may indicate growing comfort with the video analysis tools and/or with the general practice of citing video-based evidence. The average number of text-based instances of evidence decreases significantly at the $p<.05$ level between essay 1 and essay 3, $F=4.651$, $df=2$, $p=0.016$. There is a corresponding, but non-significant, increase in the average number of video-based instances of evidence, $F=1.472$, $df=2$, $p=0.242$. These opposing trends prevent the total evidence score from increasing or decreasing significantly.

Relational statements

The third research question was, "Do students learn to make more explicit connections between claims and evidence?" The hypothesis was the number of relational statements would increase as students learned to make more explicit connections between claims and evidence. There is a significant increase in these statements ($F=18.126$, $df=2$, $p<.001$). (See Fig. 6.) The difference between the means of essay 1 and essay 2 is significant at $p<.05$, and the difference between essay 1 and 3 and between essay 2 and 3 is significant at $p<.01$.

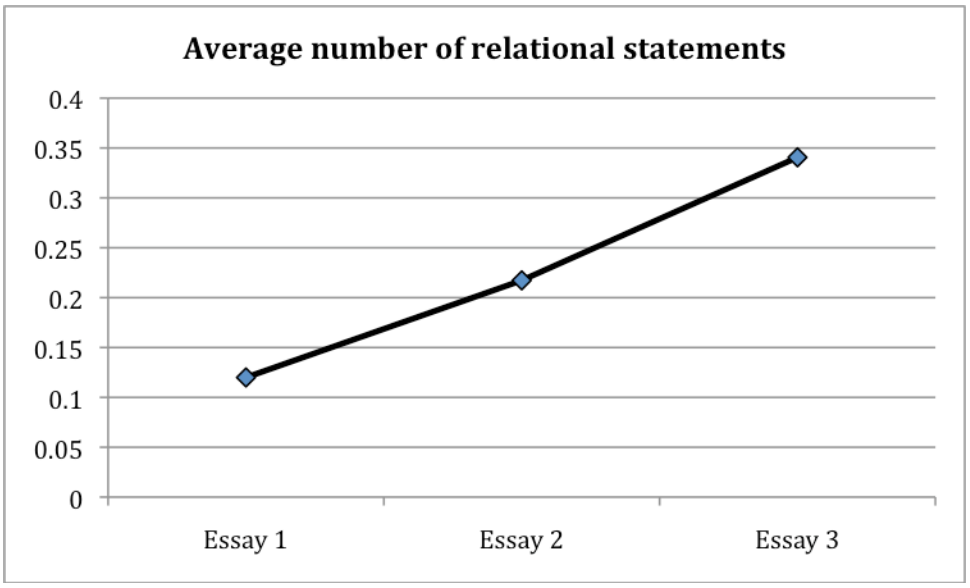

Fig. 6: Each data point represents the mean of the students' average number of relational statements in a given essay. The average was calculated by dividing the number of relational statements by the number of sentences in each essay.

Modest statements

The fourth research question was, "Do students learn to be more modest, by either qualifying their interpretations with conditional language or stating what information is required to be more certain?" The hypothesis was the number of these "modest" statements would increase as students learn to qualify their claims and/or identify missing evidence needed to make stronger claims. The average number of modest statements increases significantly ($F=36.0221$, $df=2$, $p<.001$), particularly by the third sample. (See Fig. 7.) Interestingly, the difference between the means of essay 1 and essay 2 is non-significant, but the difference between essay 1 and 3 and between essay 2 and 3 is significant at $p<.01$. Only one student's number of modest statements decreases between essay 1 and essay 3.

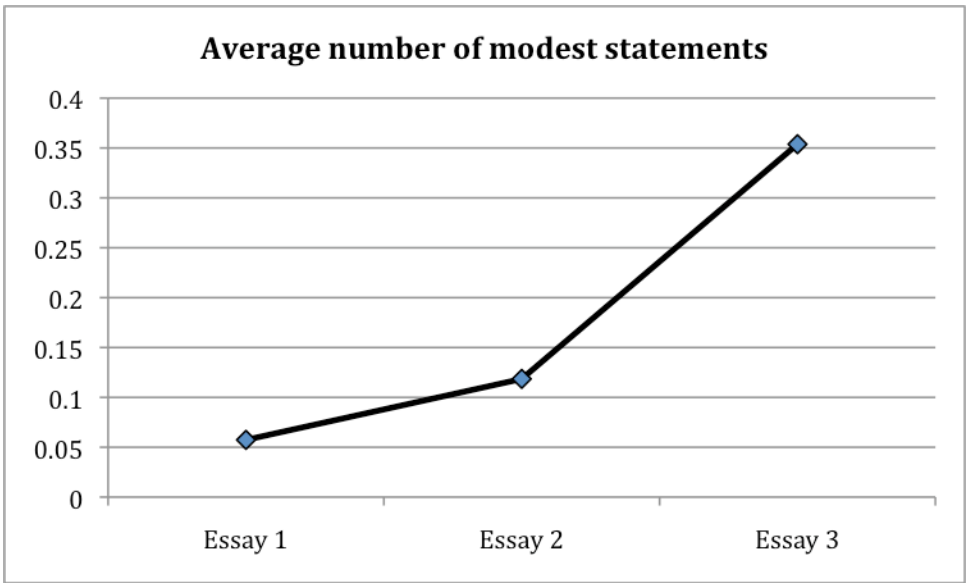

Fig. 7: Each data point represents the mean of the students' average number of modest statements in a given essay. The average was calculated by dividing the number of modest statements by the number of sentences in each essay.

References

The references to literature category accounts for language that did not fit in any of the above categories. The hypothesis was the number of reference statements would decrease as students began to rely on their own interpretations to explain what they observed. The data show no significant difference among the means ($F=2.8587$, $df=2$, $p=0.070$). Only six students' references increase between essay 1 and essay 3.

Discussion

Taken separately, the variables show significant change in the expected direction. The number of claims decreases across the three essays, perhaps because students learned to make fewer claims in order to better defend them in the space allotted. Similarly, the ratio of evidence to claims increases, or, conversely, there is a decrease in the ratio of

claims to evidence. The number of relational statements appears to increase as students take greater care in explaining why their selected evidence supported their claims. Most interestingly, perhaps, the amount of "modesty," as reflected by the students' use of conditional language as well as statements that acknowledged missing evidence, increases dramatically across the three essays.

The larger question is whether these results imply that students developed an ability to engage in more sophisticated arguments. According to the simple definition of informal argument offered earlier, the students do appear to learn to better coordinate their claims and evidence: they tip the ratio of these two elements in the right direction, and they learn not to allow claims and evidence to stand alone, without explaining what the evidence shows substantively (not merely recounting the events captured in the video), and how it relates back to the claim.

The students also show progress in their development of intellectual humility; by essay 3, many students appear to have acquired a respect for evidence and the reasonable limitations of their claims.

What factors are responsible for producing these results? Interpretation and argument skills were expected to improve in the course context generally. The evidence provided by assignments suggests that students do indeed improve these skills within the VITAL environment and the course experience as a whole. Students' use of VITAL may be very important in producing the effect, but other elements of the course contribute as well; the assignments within VITAL were embedded in an environment in which argument skills were modeled in lecture and encouraged in discussion, sometimes implicitly and sometimes explicitly. Further research is needed to investigate the nature

of the improvement in richer detail and to determine the extent to which various factors, such as VITAL itself or other aspects of the course experience, influence the improvement.

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