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An application of Habermas' rationality to the teacher's actions: Analysis of argumentation in two classrooms

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In this paper, I argue that Habermas' components of epistemic, teleologic, and communicative rationality provide insight into the differences in teachers' support for collective argumentation. I examine the teacher's supportive actions in two different classrooms. In their interactions with students, the teachers emphasize different components of rationality. I suggest that teachers may act in ways to support students' development of components of rationality by asking different kinds of questions and raise the question of whether it is useful to consider the components separately.

Keywords: Argumentation, proof, geometry, teaching.

Introduction

It is generally accepted that argumentation and proof are crucial to the study of mathematics. Argumentation has been shown to be particularly important to the learning of mathematics through social interaction. Numerous examples in the mathematics education literature have unpacked aspects of arguments in elementary and secondary classrooms (e.g., Krummheuer, 1995; Pedemonte, 2007); these cases have focused on the learning of mathematics through participation in argumentation, the similarity of argumentation to the structure of proof, the analysis of proof as argument, and the role of the teacher within argumentation. Recent research has examined "successful" argumentation within classroom discussions (Boero, 2011), argumentation that does not meet expectations (Cramer, 2015), and different aspects of rationality with respect to argumentation (Boero & Planas, 2014).

This paper explores the differences in collective argumentation that can be observed in classrooms. It addresses a temptation to characterize the argumentation in one classroom as productive and that in the other as problematic and suggests an explanation for the teacher's actions in each case can be found in Habermas' (1998) constructs of rationality as described by Boero (2006).

Background

In this paper, we explore the teacher's role in argumentation through the combined lenses of our interpretation of Toulmin's (1958/2003) description of arguments in multiple fields, our framework for teacher support of collective argumentation (Conner, Singletary, Smith, Wagner, & Francisco, 2014), and Boero's (2006) description of Habermas' (1998) components of rationality.

Habermas' (1998) components of rationality have been applied to argumentation in several ways. Boero (2006) analyzed a seventh grade student's argument (and the reactions of teachers to the argument) using three interrelated components introduced by Habermas: epistemic, teleologic, and communicative rationality. Boero gave the following explanation of these components.

Epistemic rationality is related to the fact that we know something only when we know why the statements about it are true or false...the crucial requirement is that the person has elaborated an evaluation of propositions as true and is able to use them in a purposeful way and to account for their validity. The teleologic rationality is related to the intentional character of the activity, and to the awareness in choosing suitable tools to perform the activity...The communicative rationality

is related to communication practices in a community whose members can establish communication amongst them...rational means that the subject has the intention of reaching the interlocutor in order that he/she can share the content of communication, with an adequate and conscious choice of tools to make it possible. (p. 189–190)

Boero concluded that the student acted in a rational way, using all three components of rationality, while the teachers' behavior did not meet these criteria for rationality.

Recently, multiple researchers have taken up Habermas' components of rationality to examine a range of issues with argumentation (see Boero & Planas, 2014). Within Boero and Planas' (2014) research forum report, Douek introduced the construct of rational questioning, suggesting that teachers can ask students questions in order to "organize the mathematical discussion according to the three components of rationality" (p. 1-210). The teacher plays an essential role in organizing and supporting argumentation in classrooms. In this, Habermas' construct of communicative rationality is key, but the teacher can also influence the teleologic and epistemic rationality of the classroom community.

We follow Krummheuer (1995) in adapting Toulmin's (1958/2003) description of argumentation to collective argumentation in mathematics classrooms. We define collective argumentation broadly as any instance in which students or teachers make a mathematical claim and support it with evidence. Our adaptation of Toulmin's diagrams (see Figure 1) includes the use of color (line style) to denote the contributor(s) of components of an argument and the addition of contributions and actions of the teacher that prompt or respond to parts of arguments (teacher support).

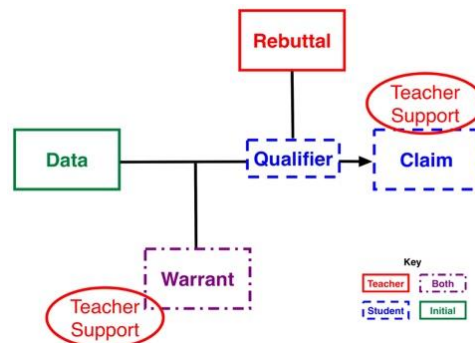


Figure 1: Adaptation of Toulmin's (1958/2003) Diagram for an Argument

Our framework for teacher support of collective argumentation includes three main kinds of supportive actions: direct contributions of argument components, questions, and other supportive actions such as gestures or diagrams (Conner et al., 2014). We defined a teacher's support for collective argumentation as any teacher move that prompted or responded to an argument component. We used Toulmin's (1958/2003) model to classify the direct contributions of argument components, and we used an inductive approach to develop categories of questions and other meaningful supportive actions the teacher used. More details about the development of the framework are available in Conner et al. (2014).

Methods

The analyses in this paper are based on data collected from a project that investigated the beliefs and argumentation practices of a cohort of secondary prospective teachers in the southeastern United States. In particular, the data for this paper include video recordings, field notes, and other artifacts

from two days selected from a unit of instruction in each of two student teachers' (Ms. Bell and Ms. Carr, all names are pseudonyms) classrooms. These days were selected as representative of the variety of instructional moves observed in each teacher's instruction. We diagrammed every episode of argumentation from these days of instruction and categorized every supportive action of the teacher that we identified. We used Habermas' (1998) components of rationality to examine the actions of the teacher within our framework categories.

Episodes from two classrooms

The episodes presented and diagrammed below capture essential qualities of the instruction in each teacher's classroom. For each teacher, we present an excerpt of an episode of argumentation, our interpretation as captured by a partial diagram, and a summary of the teacher's support for argumentation in the class. We then examine the teacher's (and students') actions using Habermas' (1998) components of rationality and argue that the teacher's actions with respect to argumentation reflect her teleologic rationality. That is, we examine the teacher's supportive actions as tools to infer her goals for students' learning and contributions to class and her classroom norms.

Ms. Carr's Class

This episode occurred when Ms. Carr and her students were at the beginning of a unit on congruence. The students had not yet learned any of the triangle congruence theorems. Thus they were proving figures congruent by their definition of congruence, which required all corresponding sides and all corresponding angles to be congruent. Ms. Carr posed the problem in Figure 2 to her class; the students and she worked together to mark relevant parts of the figure, and when we enter the discussion, they had modified the figure as shown. (They had extended segments BC, AB, and CD, and they marked angle ABE and angle DCE as angles of interest.)

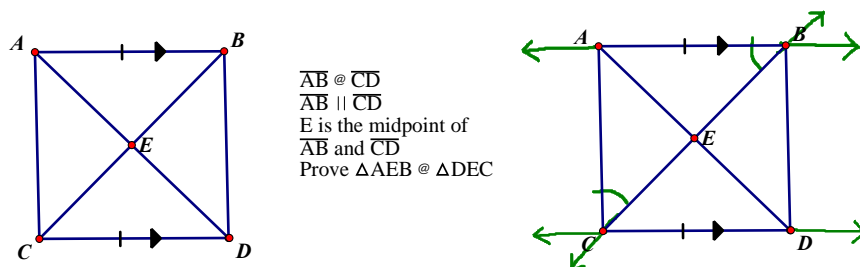


Figure 2: Initial Problem in Ms. Carr's Class and Modification

- 541 Ms. Carr: Okay. So, what I have marked up here in green, we said are what? What is their special relationship?
- 543 Alice: They are alternate interior angles.
- 544 Ms. Carr: They are alternate interior. Ok. So, let's write that down. ABE, let's call it, and angle, what is it? Angle DCE...[writes $\angle ABE$ $\angle DCE$ on board, leaving space between the two angles] [unrelated conversation/interruption] Now, I left some space in there. What symbol needs to go, what do we know about these?
- 549 Students: {congruent} {congruence}
- 550 Ms. Carr: Awesome. They are congruent. Why do we know that?
- 551 Cameron: Because they are alternate interior angles.

552 Ms. Carr: Alternate interior angles theorem [writes by alt. int. angles thm. on board]

Figure 3 shows the diagram of this excerpt of an argument. Notice that three parts of the argument were contributed by students with a significant amount of support from the teacher. Ms. Carr asked a question that prompted each of the argument components, pointed at or wrote something on the board for each of them, and restated or affirmed each part as well.

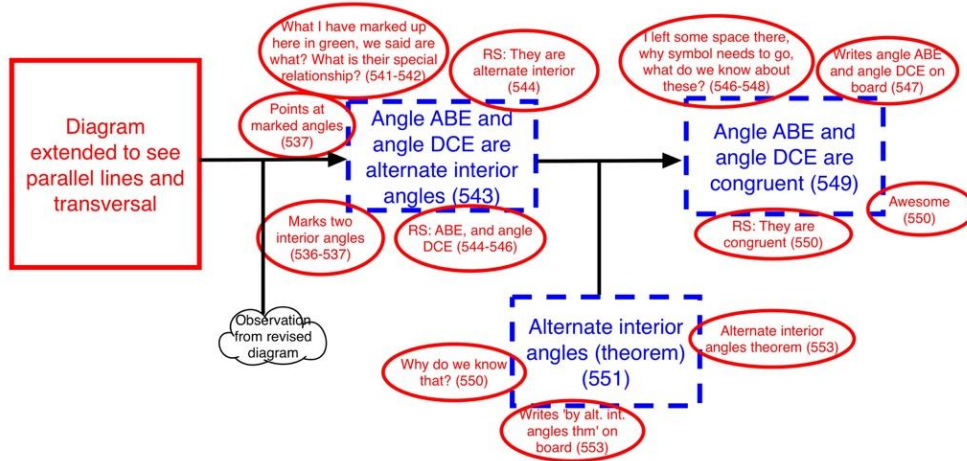


Figure 3: Diagram of First Excerpt of Argument in Ms. Carr's Class

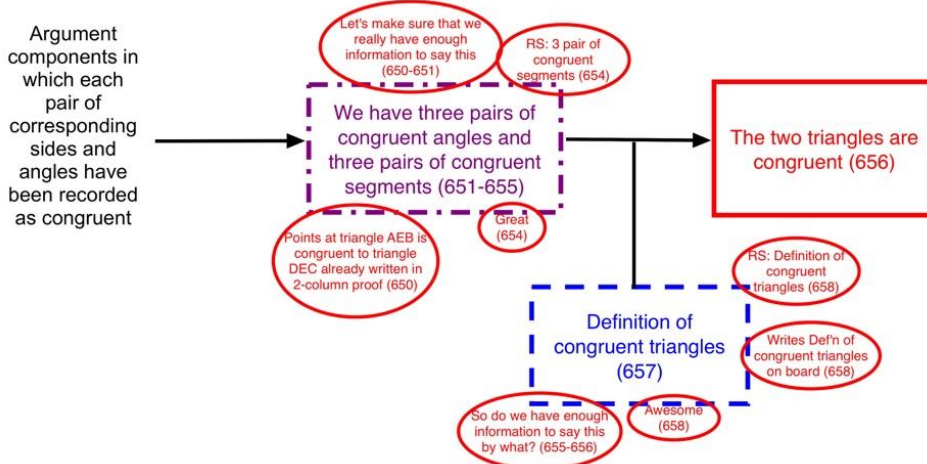


Figure 4: Diagram of Second Excerpt of Argument in Ms. Carr's Class

A little more than five minutes later, Ms. Carr and her students had compiled all of the information about the figure into congruence statements. They ended the proof construction by verifying that they had three pairs of congruent segments and three pairs of congruent angles, warranting the claim that the triangles were congruent with the definition of congruent triangles. In the diagram for this excerpt of argument (Figure 4) we see that the teacher contributed the final claim, the teacher and students jointly contributed the data, and a student contributed the warrant. Ms. Carr prompted both the data and warrant, and she supported each of these components with actions such as repeating, pointing, and writing on the board.

Ms. Carr supported her students in making arguments by contributing many argument components, including approximately one-half of the warrants in her class. In addition, she prompted most argument component by asking questions (primarily factual answer and elaboration questions,

Conner, et al., 2014), and she provided additional support for these argument components using other several kinds of supportive actions (including focusing, evaluating, informing, and repeating actions, Conner, et al., 2014). The importance of Ms. Carr's choices in supporting her students' arguments becomes clear as we reference Habermas' (1998) components of rationality. Ms. Carr asked several questions (line 541, lines 547–548) that requested a factual answer and then asked for elaboration by asking the students to justify that answer in line 550. In this interchange we see an assumption by Ms. Carr of her students' epistemic rationality. She invited them to participate in the argument and indicated by her questions that they should have reasons for their statements. This may be an instance of Douek's rational questioning, as described in Boero and Planas (2014), although Douek's rational questioning seems to presuppose all three aspects of rationality. Ms. Carr seemed to focus on epistemic rationality for her students, while Ms. Carr's own statements and actions indicate a focus on communicative rationality for herself. She repeated or restated (and often wrote the statement on the board) all of the student-contributed components of the arguments. If we consider the teleological rationality of Ms. Carr's actions, they appear to be very goal-directed. Her goal was student understanding of concepts and procedures. In search of that goal, her goal or focus for students was on epistemic rationality. She intended to make sure that they knew the reasons for the statements that were made. Across the class periods, this was evidenced by her many questions prompting argument components as well as her pervasive prompting and providing of warrants for arguments.

Ms. Bell's Class

In Ms. Bell's class, the excerpt exemplifying her instruction involved a task in which students had measured the interior angles of several polygons. Students were asked to find a formula for the sum of the interior angles of an n -sided polygon. The brief snippet of class we examine occurred when a student was presenting his group's work at the end of class. Prior to this excerpt, a student representing a different group presented a solution. Martin, the student in this episode, asked to present his solution because his group found the solution in a different way from the first student.

- 1444 Martin: All right. I had the chart. This is the sides of the figure. That would be the sum of the interior angles.
- ... [Martin talks as he constructs a chart containing numbers of sides and corresponding sums of interior angles for polygons with three to eight sides]
- 1456 Martin: And then it changes by 180 degrees each time.
- 1458 Ms. Bell: So Martin, the fact that it changes by the same number each time, when you're going up by one side, tells you what?
- 1460 Martin: That it has--that that's the slope.
- 1461 Ms. Bell: That's the slope. Which means it's? Karin, you said it earlier. What does that mean when it's?
- 1463 Martin: Linear.
- 1464 Ms. Bell: Linear. It's linear, right? If it changes the same amount each time, when you're going up by 1, it's going to be a linear function.
- 1466 Martin: So I did $f(s) = 180s$
- 1467 Ms. Bell: What is that 180?
- 1468 Martin: It's the slope. But that doesn't work out right, because 180 times 3 is like
- 1470 Ms. Bell: 540

- 1471 Martin: [writes $180 \times 3 = 540$] 540. But then I just subtracted 180 from 540 and it equals 360. Yeah. So, subtract 360. [Writes $f(s) = 180s - 360$]
- 1475 Ms. Bell: So same thing; he got it a different way. When he got to the 540--so he got this 540 out when he plugging in 3 for his s , and he got 540. We wanted to get 180 when we plug in a 3. So he said, 'how am I going to get from 540 to 180?' So he found the difference between them and subtracted from this product. Do y'all see that?
- 1482 Martin: It works with all of them too.

Figure 5 shows the diagram of this argument. In this argument, Martin (the student) contributed all of the components except one warrant. Ms. Bell prompted three of the components with questions, and she supported five of the components by restating or rephrasing Martin's contributions. In general, Ms. Bell asked questions of multiple kinds to prompt argument components, and she contributed some components of arguments, but only about one-eighth of the contributed warrants. Students in Ms. Bell's class seemed to contribute more autonomously to arguments, as evidenced by components that were neither prompted by nor responded to by Ms. Bell.

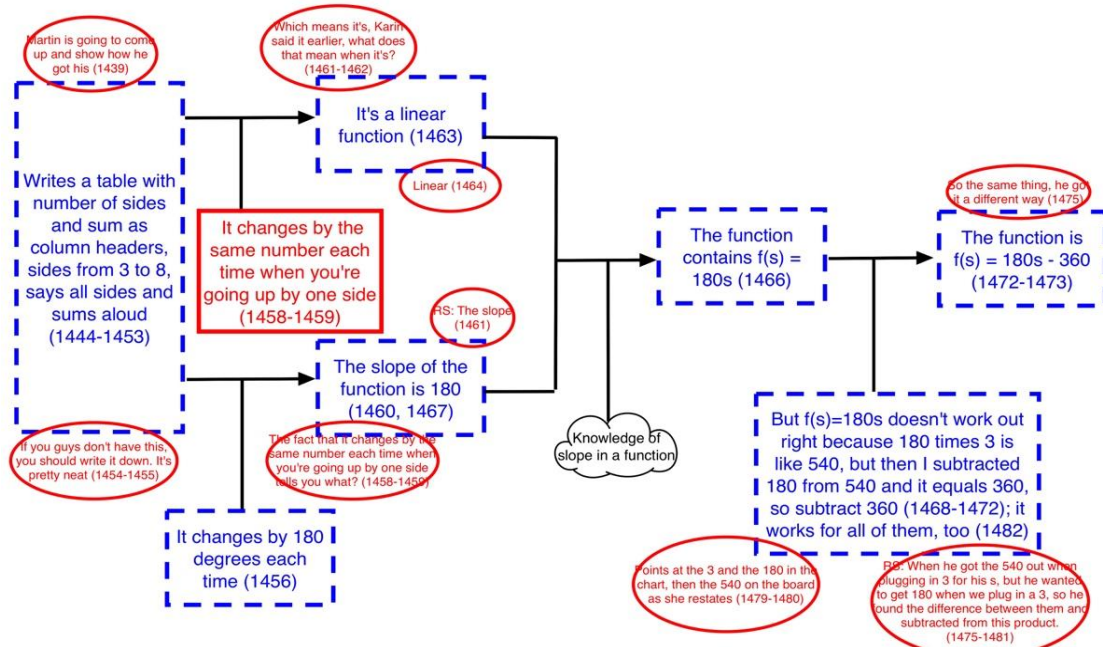


Figure 5: Diagram of Argument from Ms. Bell's Class

We see evidence of Ms. Bell's teleologic rationality (Habermas, 1998) in her actions and questions in support of her goal of engaging students in doing mathematics. Ms. Bell modeled actions related to all three components of rationality, and she seemed to encourage all three components of rationality in her students. Ms. Bell's actions show a strong emphasis on developing her students' communicative rationality, not only in her communication with her students (see line 1475 in which she restates the student's argument), but in her encouragement of her student to communicate his ideas more clearly (e.g., line 1458) and in the student's instinctive actions and statements (e.g., lines 1444 and following in which he explained the entries in the chart he drew on the board), which illustrate norms established in this class. Several times after the student gave a claim and warrant, Ms. Bell seemed to slow down the presentation to make sure it was clear to others, enhancing their understanding of communicative rationality. But instead of giving all the information herself, she

asked the student to do so (line 1467). She seemed to be balancing engaging in acts of communicative rationality herself and encouraging her student to do so. In addition, Ms. Bell assumed epistemic rationality in her student and encouraged him to express it (line 1458). The beginning and end of the episode evidence a classroom norm regarding goal-directed behavior and use of appropriate tools (lines 1444–1455; line 1482). The student indicated by his final statement that he had intentionally completed his goal of finding, expressing, and justifying the formula for the sum of the interior angles of a polygon, showing the teacher's encouragement of behavior exhibiting teleologic rationality. This episode illustrates a teacher's use of rational questioning, bringing the students' voices into the discussion and encouraging their implementation and understanding of all three components of rationality (Douek in Boero & Planas, 2014).

Discussion

The argumentation we observed in the two classes was very different. One classroom was characterized by a focus on students' epistemic rationality and the teacher's communicative rationality. The argumentation in this class seemed to be both somewhat shallow and more formal and proof-like. The other classroom was characterized by a more balanced focus on students' epistemic, communicative, and even teleologic rationality, and we saw the argumentation in this class as somewhat informal but characterized by student autonomy. The second classroom also illustrated some intentionality and awareness of components of rationality (although not with those words) in the interactions, as Douek suggested was necessary (Boero & Planas, 2014). The teachers also used different kinds of tasks in their classrooms. The choice of tasks in each classroom may also be related to the teachers' intentions with respect to the components of rationality; more research is necessary to examine this question.

Differences were observed in the kinds of questions each teacher asked. Ms. Bell asked a wide range of questions, while Ms. Carr asked primarily factual answer and elaboration questions. Perhaps the kinds of questions teachers ask may indicate their focus on a particular component of rationality. It is an open question as to the significance of these components of rationality in a mathematics class, but if we want to encourage students to view mathematics as rational and to act in rational ways when engaging in the study of mathematics, then it seems that it would be helpful for teachers to act in ways that encourage all components of rationality at appropriate points (as Douek suggested, to engage in rational questioning, Boero & Planas, 2014). As Boero (2006) suggested, teachers can model the components of rationality for their students at appropriate times. Perhaps introducing these components of rationality to teachers could provoke a wider focus. Examining the kinds of questions teachers ask in conjunction with their argumentation shows promise for revealing which components of rationality are privileged in their classes. And these components of rationality provide a useful explanatory mechanism for the differences in support for argumentation observed in classrooms. Future research will have to examine how important it is for a teacher to engender all components of rationality and whether it is possible or productive to address each component separately.

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