

The Discourse of Argumentation

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Article history	This study seeks to characterize the discourse of classrooms that utilize the Science Writing Heuristic (SWH), an approach to Argument Based Inquiry (ABI). Linguistic behaviors that lend themselves to inclusion in a discourse that supports argumentation are examined, such as frequency of dialog interchange and instances of student-student speech. Students and teachers in SWH classrooms utilize linguistic behaviors that support argumentation significantly more frequently than their counterparts in classrooms that utilize more traditional pedagogies. The linguistic behaviors characterized in this study allow us to more clearly describe the discourse that develops under the SWH approach. This discourse is specifically illuminated as a discourse of argumentation, in which the importance of student voice is a key underlying value.
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Introduction

The importance of argument in teaching science has been well documented. It has been found that argument enhances students' understanding of scientific concepts, that it improves their understanding of the science process, and that it encourages the development of critical thinking skills by making their thinking processes more transparent (Jiménez-Aleixandre, 2007; Abi-EI-Mona, 2006; Zembal-Saul, 2002; Crawford, 2005). Mastering the language of argumentation is a key aspect of developing scientific literacy (Cavagnetto, 2010). Although there is a general consensus that argument is important, there are a variety of ways in which argument has been described and defined. Argument can be described as a process, as in Kuhn (1992, 1993), or categorized into components as in Toulmin (1985). Specific steps and sequences may be considered necessary (Leitao, 2000), or various types of reasoning skills must be considered evident (Lawson, 2003), for fruitful argumentation to occur.

Work on argumentation in science classrooms has examined many aspects of argument, and these ideas may all describe valid facets of argumentation, from epistemologies to conventions of speech. Argumentation has previously been described as the means of scientific discourse (Lemke, 2000). Accordingly, argumentation can be considered the language of science (Tippett, 2009; Duschl, 1999). When we examine the literature that describes argumentation it becomes clear that the term language in the above description is insufficiently broad. Argument appears to contain properties beyond language involving underlying thought processes and beliefs. By considering Gee's work on discourses (1988, 1990) it is possible to reframe these, and other, understandings of aspects of argumentation into a coherent whole. Viewing these many aspects of argumentation as elements of a discourse will help us to develop a fuller, more comprehensive notion of what argument is for both teachers and students. In this paper we attempt to describe argumentation in an inclusive,

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discourse-based fashion.

To do this, we must clearly describe what we mean by discourse. Gee (1990) distinguishes “little” and “big D discourses”. Discourse in common parlance refers to communication; one may engage in discourse with a colleague. “Big D” Discourse also refers to communication, but in a larger sense. Discourse in this meaning, which is how the term will be used through the rest of this text, is not just about a specific instance or type of communication, but encompasses the ways of communicating and signaling used by a community. Thus, under this framework, the various discipline-specific ways in which the scientific community engages in communication, from discussions in the lab to conference presentations to journal articles, are all part of a larger discourse. Particular beliefs, conventions and ways of being and doing as regards to talk, writing, speech and listening all fall under discourse.

Viewing argumentation as a discourse has some complications, as Gee describes discourses as emergent properties of communities (1990). When we consider a discourse of argumentation, to what community are we referring? While argumentation occurs in the science classroom, developing the cognitive skills and linguistic moves used in argumentation can lead students to gain a larger “grasp of practice” (Ford, 2008). Ford describes “grasp of practice” as a state wherein one is able to implicitly know when and how to engage appropriately in the practice; in this case, the practice of interest would be argumentation. The concept of “grasp of practice” can be used to refer to how member of the scientific community implicitly or culturally know how to act appropriately and participate in the practice of science (Lave & Wenger, 1991). Gee would understand this implicit or cultural knowledge to signify that the individuals had become participants in the discourse community of science (1990). However, while the argumentation skills developed in inquiry-based science classrooms closely resemble those used by adults engaged in science, it is debatable as to whether children engaged in science class can actually be considered members of the scientific community (Bernstein, 2000). The “grasp of practice” seen in adult members of the scientific community differs from the “grasp of practice” educators hope children will acquire in the science classroom, which seems to indicate that science and argumentation are related but separable practices.

In relation to this, Gee states that the discourses of communities are learned through apprenticeship. Schoolchildren tend to have brief, if any, contact with adult members of the scientific community (Shibeci, 1986); it cannot be said that children studying science engage in a meaningful apprenticeship with adult scientists. If they are apprenticed to anyone in the theoretical discourse community we describe, it is their schoolteachers. Elementary schoolteachers often have little training in the sciences; some teacher preparation programs require no college-level science education (Arizona Department of Education, 2012; Alabama Department of Education, 2007). Thus, it seems a stretch to consider them members of the scientific community. However, by considering to whom elementary school students are apprenticed as they practice the discourse that occurs in science classrooms, we can start to elucidate to which community they must be apprenticing; that of rational adults, and what “grasp of practice” we hope they will develop: that of argumentation, not of science.

Argumentation is not a skill that is useful only in the context of science education, other school topics, or the scientific community. Argumentation; the skills involved in answering questions with claims that are supported by evidence, is a key skill of rational adults. Though the science classroom is not the only place we anticipate children will develop and practice this skill it is one of our society’s primary settings for instilling and developing these practices in our children. We do not have all children take science classes because we want them all to become scientists any more than we have all children take mathematics classes to become mathematicians. Children are given an education in these fields, and others, because they are assumed to impart general skills that are necessary for adults in our society. The intent of inquiry-based models of education is to create in

the science classroom not a place where children memorize facts about science, but a place where they learn argumentation skills in the context of discovering and exploring the natural world. In the science classroom, students are apprenticed to teachers so that they can enter the community of rational adults, who utilize the discourse of argumentation.

Thus, while the discourse of argumentation is not particular to science, or to the science classroom, one of the key purposes of the modern science classroom is to apprentice students to this discourse. As Gee discusses, the secondary discourses taught in schools may differ by greater or lesser degrees from the primary discourses children learn as they grow up in their home communities. The differences between children's primary and secondary forms of discourse can be a significant social justice issue. For instance, in the United States Black children are often marginalized in school because their primary discourse differs in several linguistic aspects from mainstream discourse, whereas White children, whose primary discourse more closely adheres to mainstream discourse, are rewarded for skills they have already developed at home (Erikson, 1987). Sociocultural conflicts of this type are often studied under the umbrella of language and literacy, but are also known to occur in the science classroom. Though not discussed in terms of discourse, studies indicate that minority children offer experience difficulties in science class as a result of feelings of alienation based on, amongst other factors, linguistic differences (Rakow, 1998; Duran 1993). As we consider how best to utilize the opportunities provided in the science classroom to engage all students in the discourse of argumentation, we must consider these potential conflicts between students' primary discourses and the school discourse to which they are being introduced. To this end, it can be helpful to think of science from the perspective of a second language (Yore et al, 2004). Through the development of novel, inclusive, science teaching practices, we can bring together students from a variety of language and discourse backgrounds (Hildebrand, 2001).

An inquiry-based method of teaching and learning known to promote the success of students of all demographic groups is the Science Writing Heuristic approach, or SWH (Author, 2007) We speculate this may be due to the inclusive discourse style that develops within SWH classrooms (Author, 2012). Accordingly, this study, which seeks to describe teacher and student talk in argumentation in the science classroom and examine how this contributes to our understanding of argumentation as a discourse, has been conducted in traditional science classrooms and science classrooms utilizing the SWH approach, with the goal of determining what language characteristics correlate with the presence of argumentation. The SWH approach's ability to foster argumentation has been previously established (Author 2010, 2007, 1994).

As we seek to understand the discourse of argumentation we will first focus on spoken language characteristics. This aspect of discourse was chosen because of its relative ease of observation and because elementary school children appear to be often more able to clearly express themselves in talk than writing, though the issue is understudied. When we consider the characteristics of spoken language we must remember that language consists of far more than grammar and words. Talk and language are non-neutral; they always convey messages beyond those contained in their vocabulary (Fisk 1994). Ways of talking include tone, tempo, conventions for dialog exchange, non-verbal signaling, and many other markers (Gee, 1988). Many of these ways of talking, such as tone, tempo, and the use of formal vocabulary, have already been described by the author (2012) as they relate to the discourse of SWH classrooms.

In this paper as we begin to describe the discourse of argumentation, we recognize that scientific argumentation can be framed as dialog (Duschl, Schweingruber, and Shouse, 2007). Dialog is not simply the presence of two or more voices in a discussion. Dialog can be thought of as an occasion where these voices flow through one another, developing, turning, and reflecting upon ideas (Issacs, 2003). Dialog is a form of deeply engaging with the other, allowing for exploration of and complexity in ideas through participation and interrelationship (Schein, 1993). Accordingly, as we look for language characteristics indicative of argumentation, we will examine signs of dialog.

These will include the frequency of dialog interchange between students and teachers and amongst students, the space permitted for student-student talk, and the presence of speech summarization.

The frequency of dialog interchange, or how often speakers change in the classroom, is a logical indicator of quality dialog when we define dialog as involving flow, as above in Issacs. Building upon this idea, examining the frequency of dialog interchange both between students and teachers and amongst students would allow us to determine if the discourse of argumentation in particular classrooms exists purely between students and teachers or if it disseminates into students' peer interactions.

An environment ripe for dialog is somewhat unpredictable; it is negotiated as both students and teachers pick up and develop the statements of students (Boyd and Rubin, 2006). An important indicator of classroom dialog is that, while the teacher's voice remains significant, it becomes only one of many voices (Nystrand et al, 2003). As teacher voice contributes less to the classroom, more conversational turns and thus more meaningful dialog can occur (Boyd and Rubin, 2006). When teachers utilize the SWH approach students engage in more talk (Martin 2009). These studies all indicate that student-student talk is a meaningful component of dialog.

Speech summarization also indicates the presence of dialog, for in dialog it is necessary that listeners conceptualize the spoken thoughts of others so that their own thoughts can be developed (Vygotsky, 1987). Though Vygotsky would argue that this conceptualization could take place internally, instances of observed speech summarization can provide evidence that these internal processes are occurring in both students and teachers.

As we move towards the experimental portion of this text, it should be stressed that the purpose of this study is not to define a discourse of argumentation. Rather, we seek to present discourse as a theoretical frame for the unified study of argumentation, and to examine the above linguistic moves to establish their correlation with environments in which argument is known to be fostered.

Methods

Both quantitative and qualitative methods were utilized in this research. The qualitative work consisted of detailed notes regarding classroom observations made at eight schools, four using the SWH approach and four using traditional science practices, over the course of six months. All schools utilized were located in rural to suburban areas with predominantly White populations. Quantitative assessment of language formality was done at the above eight schools as well as nine others, five of which used traditional instructional and four the SWH approach. These schools were visited by field researchers who did not engage in detailed note-taking or teacher interviews. All of these schools were also located in rural to suburban areas with predominantly White populations, though sites were geographically distant from each other. This geographic distance was intended to reduce the possibility of linguistic behaviors associated with localized cultural pockets falsely being recognized as globally significant.

All visited classrooms were assessed via the Spoken Language Argumentation Characterization Tool (SLACT), which consists of 5 Likert-scale measures assessing elements of student and teacher language. The instrument is reproduced below.

1. Never 2. Infrequently 3. Sometimes 4. Frequently 5. Always

Teacher Speech and Listening

1. Summarizes student speech.	1	2	3	4	5
2. Engages in frequent dialog interchange.	1	2	3	4	5
3. Student-student talk occurs in directed discussion.	1	2	3	4	5

	Student Speech and Listening				
4. Summarizes student speech.	1	2	3	4	5
5. Engages in frequent dialog interchange.	1	2	3	4	5

The behavior of the student body as a whole was scored for the student portion of the questionnaire, rather than relying on observation of any one particular student. High scores on all measures of the SLACT were assumed to indicate the presence of argumentation (Duschl et al, 2007; Vygotsky 1987; Issacs, 1993; Boyd & Rubin, 2006; Nystrand et al, 2003).

Analysis of SLACT data was performed in PASW18 using ANOVA. Significant differences in language style between SWH and traditional classrooms were revealed.

These differences are further explored qualitatively. Relevant excerpts of classroom dialog are reproduced and analyzed to reveal the ways in which the presence of the above language behaviors contributed to scientific argumentation.

Results

1. Quantitative Results

Table 1: Argumentation behaviors in teachers

Teacher Trait		df	Mean Square	F	P
Summarizes s speech	Between Groups	1	48.095	43.515	.000
	Within Groups	111	1.105		
	Total	112			
T-S Dialog interchange	Between Groups	1	65.325	42.209	.000
	Within Groups	111	1.548		
	Total	112			
S-S speech with teacher	Between Groups	1	36.611	1.888	.000
	Within Groups	111	1.888		
	Total	112			

*Significance: $p < 0.05$

As seen in Table 1, there are significant differences in the frequency at which SWH and traditional teachers utilize discourse behaviors that allow for argumentation, with SWH teacher being significantly more likely to summarize student speech, engage in frequent dialog interchange with their students, and allow students to speak to each other while the teacher is directing a conversation.

Table 2: Argumentation behaviors in students

Student Trait		df	Mean Square	F	P
Summarizes s speech	Between Groups	1	12.065	18.047	.000
	Within Groups	111	.669		
	Total	112			
S-S Dialog interchange	Between Groups	1	78.523	59.378	.000
	Within Groups	111	1.322		
	Total	112			

*Significance: $p < 0.05$

As seen in Table 2, the discourse of SWH students contains aspects that allow for argumentation at significantly higher frequencies than students in traditional classrooms, including summarizing the speech of other students and engaging in dialogs with each other.

2. Qualitative Results

From the tables above, it is clear that there are powerful, statistically significant differences in the ways traditional and SWH classrooms establish conventions for dialog. Classroom observations provided numerous examples of how these differences drove successful argumentation for students and teachers. Consider the following excerpts from field notes, where a teacher from a traditional classroom and then an SWH classroom lead their students in a discussion about life cycles;

Traditional:

- 1T *T: Who can tell me what will happen next in the life cycle. Amy?*
 2T *S1: It lays eggs.*
 3T *T: And then? John?*
 4T *S2: They hatch into caterpillars.*

SWH:

- 1S *T: Who can tell me what will happen next in the life cycle? Ben?*
 2S *S1: It lays eggs.*
 3S *S2: No, it doesn't lay eggs, it dies.*
 4S *S1: Sometimes they lay eggs.*
 5S *S3: It should have two arrows there, because sometimes they lay eggs and sometimes* 6S *they die.*
 7S *T: Is that what you think we should do, everybody? Should we make two arrows here, an*
 8S *arrow for lays eggs and an arrow for dies? Zeus, you look like you have an opinion.* 9S *Can you tell me why?*

Though these classes took place in the same school district, and the children and teachers in both classes were demographically similar, the dramatic differences in their discussions of life cycles are evident. The SWH excerpt shows evidence of two statistically significant behaviors: summarization of student speech and permitting student-student speech within the context of guided discussion. Summarization of student speech is seen both by peers, as in lines 3S to 5S, where various students repeat the phrase “lay eggs”. The specific repetition of this phrase, rather than shortening it (ie, “no they don’t) or altering it (ie, “no, it doesn’t make eggs), indicates both to the original speaker and other peers in the discussion that the new speaker is engaged in active listening behavior. Speech summarization gives validity and recognition to others’ speech, even when the new speaker disagrees. Summarization of student speech by the teacher is also seen in lines 8S-9S. Again, the repetition of specific words and phrases demonstrates to all members of the dialog that the original speakers’ contributions were heard and considered valid.

The language behavior seen in the excerpt from the SWH classroom differs from that seen in the traditional classroom. In lines 1T-4T no summarization of speech by students or teachers can be seen. Low to no speech summarization was generally recorded across observations of traditional classrooms. As speech summarization validates speakers and provides a conversational thread by which dialog appears to grow, the lack of speech summarization often appeared to be linked to the absence of dialog.

An additional significant factor noted in the SWH excerpt above is the presence of student-student speech within the context of teacher-led discussion. Students engage in peer-peer speech in lines 3S-6S. This peer-peer speech, which contained elements of both construction and critique, changed and enriched this classroom’s understanding of the life cycle. Student-student speech is absent from the traditional excerpt above. While students were occasionally observed interjecting into other students’ responses to the teacher in the traditional classroom, this behavior was treated as disruptive regardless of the students’ speech content. The SWH teacher did not discourage student interjections in her classroom. Early in the school year her students would interject each other’s

speech to address the teacher. The SWH teacher molded this behavior into student-student discussion by redirecting the interjector's comments towards the student who originally spoke. In this way we can see how teachers can develop and support language behaviors that support a discourse of argumentation in their classrooms.

Student-student behavior in the absence of the teacher's immediate guidance also differed between SWH and traditional classrooms, as seen in the excerpts below. Here, students worked in small groups as they completed worksheets related to a unit on force and motion.

Traditional:

5T *S1: It took four big washers to make the car go to the edge of the table.*

6T *S1, S2, S3: write. S1 consults notebook.*

7T *S1: Then it took eight little washers and one big washer to make the car go to the edge of 8T the table when we used both washers.*

9T *S4: Where are we?*

10T *S1: How many big and little washers.*

SWH:

10S *S1: It took three big washers to make the car go to the edge of the table.*

11S *S2: Three big washers?*

12S *S3: It took their group four big washers.*

13S *S1: But their car is different.*

14S *S2: Their car is different, it has the little wheels on it.*

In these excerpts as in the pair explored above more than one statistically significant behavior can be seen. The SWH students engage in more frequent dialog interchange; conversational turns are seen each line in lines 10S-14S, whereas one speaker is responsible for lines 5T-8T. The SWH students summarize each other's speech, as seen with the phrase "big washers" in lines 10S-12S, and then again with the phrase "their car is different" in lines 13S-14S. As seen here, SWH also engage in more student-student speech with their peers. While Student 1 in the traditional student group is speaking to the other students, this students' speech appears to mirror the behavior of the traditional teacher. This student does not engage in dialog with the other members of their group. The SWH group's Student 1 did assume a leadership role, but like the SWH teacher Student 1 allows room for others to speak. Importantly, the other students appeared to come to the group discussion with the assumption that they should speak, where this does not appear to be the case for the other students in the traditional group.

In both of the contrasting cases presented above it can be seen that teacher behavior appears to shape the discourse of the classroom. The students in the traditional and SWH sections in the first pair of cases receive different amounts of space from their teachers, with the SWH students having more time and freedom to talk both with their teacher and with each other. The students in the traditional and SWH sections in the second pair of cases are observed in small group discussion. Although their teacher is not present, we are still able to observe their teacher's influence in the structure of their discourse. The SWH students speak freely with each other, with many conversational turns, and summarize each other's speech as their teacher summarizes their speech. The traditional students cede the direction of their discussion to one student who models their behavior after their traditional teacher. Other students did not engage this student in dialog, and only interrupted in order to check for "correct" information. Teachers' support of language behaviors that lend themselves to a discourse of argumentation create very different dialog opportunities for their students.

Discussion

As seen in the dialog excerpts above, during classroom observations the language behaviors under study did not tend to occur in isolation. In traditional classrooms these behaviors were rarely if ever seen, while in SWH classrooms all five studied behaviors occurred during almost every observation. This is evidence for the presence of separate discourses in these two styles of classrooms. The language conventions of these kinds of classrooms, and the social behaviors they imply, differ so significantly that a teacher or student from either community would appear quite out of place if transported to the other. Despite this, it should be recalled that when we look at the two types of classrooms under study, much about them is the same. The traditional and SWH classrooms observed in these studies do not differ greatly in the demographics of either teachers or students, and traditional and SWH classrooms were frequently observed within the same school district.

Adopting the SWH approach is responsible for the linguistic discourses we observe. In order to implement the SWH approach, teachers must introduce argument into their classrooms. This is a key difference between the SWH approach and many other methods by which teachers attempt to bring inquiry into their science curricula. Other methods, such as “inquiry kits”, only require teacher behaviors to be considered successfully implemented. If teachers go to kit training, read the required materials, and use the kit with their students as directed, the teacher can feel they have achieved success. No student behavior needs to change in the above model. With “inquiry kits”, students engage in experiences as directed by their teacher. Though they may engage in more hands-on activity than in a lecture-style science lesson, their experience is still essentially passive.

For teachers to successfully implement the SWH approach by utilizing argumentation in their classrooms they need to change student behavior. In a traditional classroom, student voice has a limited role. Students are generally expected to remain quiet unless they are called on by their teachers. When called on, their speech role is generally limited to giving “right answers” or asking “good questions”. Other student speech is often seen as disruptive in these contexts. Teachers may interpret student-student dialog in the context of teacher-led discussion as interruption, even if the students are engaged on topic. Except in expressly permitted contexts, student-student dialog outside of a teacher-led discussion is also seen as disobedient regardless of content. Dialog interchange tends to be infrequent and purely teacher-directed.

Successful SWH teachers cannot engage in argumentation by themselves; it is necessary that their students participate in argumentation with them. When student speech is an essential part of the classroom, the traditional teaching behaviors described above quickly prove counterproductive. To encourage student speech teachers summarize student speech, thus demonstrating both to the speaker and other students that their speech contributions are important. Teachers engage in more frequent and more fluid dialog interchange, giving students more opportunities to speak, and direct students to speak with each other even in teacher-led contexts. Students absorb these lessons and implement these behaviors in discussions with their peers, where significant increases are seen in the frequency of the same linguistic moves used by their teachers.

The discourse of a classroom that utilizes argumentation must by its nature differ greatly from that of a classroom that does not, as the essential values of classrooms that utilize argument are different. The necessity of student voice leads to changes in SWH teachers’ language behaviors; this would be true in any classroom that valued spoken argument. Some of the literature reviewed earlier in this paper sought to describe characteristics of argument in classrooms. When we consider argument as a discourse, these would be both elements of and products of the discourse, much as how scientific papers, presentations and panel discussions are elements of and products of scientific discourse. To successfully create these products of scientific discourse one cannot simply study their forms. One must understand and engage with their underlying values, such as empiricism. Similarly, to create arguments with clearly defined properties, one must by necessity

value all the voices of those who might participate in that argument.

Conclusion

The significantly different linguistic behaviors engaged in by members of SWH and traditional classrooms reflect distinctly different discourses. The discourse of SWH classrooms can be thought of as reflecting a discourse of argumentation, which, within a classroom context, holds as a fundamental value the importance of student voice. This difference in values may help to explain why many “inquiry-kit” type curriculum investments fail to change the discourse of classrooms. The values that underlie the discourse of argumentation change the way teachers and students communicate, allowing the many forms of argument to arise within the classroom.

The discourse of argumentation, which by necessity must value all persons engaged in the argumentation, can readily be interpreted as less harmful than traditional classroom discourse, which can be alienating and depersonalizing for students. Thus, it passes Gee’s test (1990) for what makes a “good” discourse. The discourse of argumentation as applied in the SWH classroom also allows students to make greater achievement gains than seen in traditional classrooms (Author, 2007), which provides evidence that the discourse is “good” in another sense. Adopting classroom approaches such as the SWH give teachers tools to effectively improve their classrooms from both sociocultural and academic standpoints.

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