WEBCT DIALOGUES ON PARTICLE THEORY OF MATTER: PRESUMPTIVE REASONING IN STUDENTS' ARGUMENTATION

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ABSTRACT
A way of scaffolding students to move back and forth between multiple meanings is the use of discussions that feature argumentation. Argumentation involves the evaluation of the worth, accuracy, and authenticity of various propositions. Middle years students (grade 7=28 students and grade 8=30 students) used the WebCourseTools (WebCT) "discussion board" as a platform to carry out argumentation when they studied a unit on particle theory of matter in the context of the Common Knowledge Construction teaching model (Ebenezer & Haggerty, 1999). Student postings were classified using Walton's (1996) argumentation schemes for presumptive reasoning. Twelve schemes of reasoning were observed in student postings: argument from sign (F=45), argument from cause to effect (F=25), argument from evidence to hypothesis (F=22), argument from position to know (F=14), argument from expert opinion (F=9), argument from example (F=6), argument from analogy (F=4), argument from consequences (F=3); argument from precedent (F=2), circumstantial argument (F=1), argument from commitment (F=1), and argument from waste (F=1). The three general categories based on the nature and circumstance for argument are: experiential, referential, and provisional. "Argument from sign" illustrates how Walton's schemes may be used to structure, interpret, and evaluate student dialogue for it's argumentative strength and validity. The study promotes the development of argumentative skills in the science class and suggests the use of inquiry-based conceptual change models such as the Common Knowledge Construction teaching model to facilitate argumentation.

KEY WORDS
Dialogue, presumptive reasoning, argumentation, WebCT discussion board, particle theory of matter, middle years

STUDENTS' CONCEPTUALIZATIONS OF PARTICULATE NATURE OF MATTER

Gabel, Samuel and Hunn. (1987) point out that "the ability to represent matter at the particulate level is important in explaining phenomena such as changes in state and gas law, and solution chemistry. These authors reiterate that learning the particulate nature of matter is "fundamental to the nature of chemistry itself" (p. 695). Several researchers have explored students' conceptions of the particulate nature of matter with the aim to enhance student learning of chemistry (Ben-Zvi, Eylon & Silberstein, 1986; Doran, 1972; Gabel, 1993; Gabel, Samuel & Hunn, 1987; Griffiths & Preston, 1992; Haidar & Abraham, 1991; Harrison & Treagust, 1996; Lee, Eichinger, Anderson, Berkhemier & Blakeslee 1993; Novick & Nussbaum, 1978, 1981; Osborne & Cosgrove, 1983; Renström, Andersson & Marton, 1990; Shepherd & Renner, 1982; Stavy, 1990, 1991). From these studies students' conceptualizations of the particulate nature of matter may be qualitatively described in four different ways: characterization of the structure of matter (e.g., Matter is continuous with no spacing between the particles because the particles are closely packed.); characterization of the particulate nature during phase changes (e.g., Gases have no weight because it is invisible. Molecules in ice do not move, they start moving when ice melts.); extrapolation of the macroscopic observations of matter to explain particles of matter (e.g., Molecules in the ice are hard and frozen.) and translation of Biology concepts to particles of matter (e.g., Atoms are real and alive because they move.).

Gabel (1993) concluded that instruction on the particulate nature of matter was effective in helping high school students' understanding of chemistry. Ebenezer's (2001) study also indicated that hypermedia animation of the hydrating process improved students' understanding of particle nature of solution chemistry. Hence we are of the view when the particulate nature of matter is taught, students should have opportunities to refine their thinking, engage in dialogues in support of or in opposition to ideas, take positions, and articulate their views. A way of scaffolding students' conceptualizations of the particulate nature of matter might be via discussions that feature argumentation among students.

ARGUMENTATION IN SCIENCE TEACHING

Argumentation involves the evaluation of the worth, accuracy, and authenticity of various propositions. Argumentation theory embraces analytical, rhetorical, and dialectical schemes for the evaluation and communication of knowledge claims (van Eemeren *et al*., 1996). Analytical argumentation is grounded in the theory of logic (premises to conclusions) and include, as examples, deduction, material implications, syllogisms and fallacies (Jimenez-Aléixandre *et al*., 1997). The rhetorical argumentation emphasizes the persuasion ability and the knowledge of the arguer as opposed to the consideration of evidence. This type of argument occurs, for example, when teachers assemble evidence and construct arguments for their students. Dialectical argumentation involves dynamic interactive discourse among peers and between students and the teacher in the process of building scientific concepts. Considering "argumentation as war" (Cohen, 1995) is counterproductive to the learning of science argue Duschl, Ellenbogen and Erduran (1999). These authors suggest considering argumentation as diplomatic negotiation, growth or adaptation, metamorphosis, brainstorming, and barnraising. The same researchers have employed Walton's argumentation schemes for presumptive reasoning which underpin informal logic. These authors argue, to a scientist, the major component of epistemic reasoning is presumptive in nature, and Walton's theory of presumptive reasoning suits this purpose because it resolves the question of "lack of evidence."

WALTON'S SCHEMES OF PRESUMPTIVE REASONING

Walton (1996) has outlined 25 different schemes for analyzing argumentation that involves presumptive reasoning in a dialogue. Walton points out that an argument can be weakly or presumptively reasonable, even if it is inconclusive, and yet not be a fallacious argument. The presumptive nature of arguments in everyday conversations and in conversations in the science classroom persuade us to use Walton's schemes in analyzing student discourse. Walton states, "Proper evaluation of presumptive reasoning requires a flexible tolerance, a readiness to acknowledge and correct errors and biases, and finally, an appreciation of the finer shades on meaning and shifts of presumption in argumentation" (p. 45). When students learn to evaluate back and forth the presumptive reasoning of their peers during science dialogue, they will consciously and collectively build scientific knowledge. The focus is on social construction of knowledge from relatively simple to more complex concepts and ideas through back and forth evaluation of presumptive reasoning, rather than focusing on the intricacies and structures of argument as in Toulmin's model. Toulmin (1958) presents argumentation in a decontextualized manner. No recognition is given to the interactional aspects of argument as a speech event, or that it is discourse phenomenon, which is influence by the linguistic and situational contexts in which the specific argument is embedded (Driver, Newton, & Osborne, 2000). In this sense, Walton's scheme offers the concerned parties involved in a dialogue to build on each other's arguments until they are satisfied that they can no longer intelligently prolong the dialogue.

RESEARCH QUESTIONS

The purpose of this study is to use Walton's argumentation schemes to characterize the nature of middle years students' discourse in their understanding of the particle theory of matter. Thus, this study answers the research question: What sorts of argument schemes can be discerned in middle years students' dialogues on WebCT when they are taught a unit on the particulate nature of matter using an inquiry-based conceptual change teaching model?

METHODOLOGY

This study was conducted for a six-week period at a private catholic school in Winnipeg with grade seven and eight students. Both the grades were taught an adapted version of a unit on the particle theory of matter outlined in the Manitoba science curriculum guide. Lessons on the particle theory of matter followed the Common Knowledge Construction model, an inquiry-based conceptual change model. In this teacher-student negotiated learning model, the students' conceptions were first explored and categorized. Then these various categories were used to develop a sequence of lessons to construct and negotiate meaning (Ebenezer & Haggerty, 1999).

Lessons on Particle Theory of Matter

Lessons directly connected with the particle theory of matter based on students' ideas are outlined below in Table 1.

Table 1. Lessons Directly Connected With The Particle Theory of Matter

Demonstration of solid, liquid, and gas being divided and divided. Students were asked what made up the solid, liquid, and gas. Students represented in words and in pictures what they would see if the division continued on and on. Students were put into groups to discuss the teacher categorized ideas and come up with one best idea for the group. Students presented their ideas to the large group and an interpretive discussion was carried out so that students understand that matter can be broken into smaller and smaller sub-units.
Students tested the theory that air is matter. They designed an experiment to test whether air has mass or not. Introduction to WebCT. Students posted their theories on WebCT.
Demonstration of baking soda being added to peas and water to understand that particles have space between them.
Demonstration on the expansion of solid, liquid, gas using PROE (predict, reason, observe, explain) activities. Drawing particles at various temperatures. Interpretive discussion to understand the effects of heating and cooling on the volume of solids, liquids, and gases to understand that matter generally expands upon heating, and contracts upon cooling, and the particle theory of matter can be used to explain changes of state with respect to the relative distance and motion of particles with varying temperatures.
Food coloring in cold and hot water demonstration to show the relative movement of particles with varying temperature. Students posted their theories on WebCT.
Demonstration on conduction and convection using PROE strategy. Class discussion on convection and conduction to understand how heat is transmitted through liquids, gases, and solids. Students posted their theories on WebCT.
Sugar in water and ice in water peer activity. Students representing dissolving vs melting in cartoon format. Students then presented their cartoons to the class. Large group interpretive discussion to understand the difference between dissolving and melting. Students were asked to describe solutions by using the particle theory of matter.
Students making old-fashion ice Cream to understand how salt can be added to depress the melting

point of ice. The focus was on particle theory of solutions. Students representing particle theory of matter during phase changes and in solution through dance using balloons.

Through analysis, assessment, and interpretation of ideas in the above lessons, students demonstrated theory building. They represented ideas in pictures, words, graphs, WebCT discussion board, the PROE (predict, reason, observe, explain) strategy sheets, and dance. They worked within a small group environment to perform an investigation to seek for evidence and reason. Students further analyzed and assessed the results obtained from investigations, and through dialogue came to consensus on various theories of the particulate nature of matter. They validated their group theory by negotiating in large group interpretive discussion. They also became familiar with the use of the computer for representing ideas and theories (e.g., concept mapping, pictorial representation), for constructing graphs, and for carrying out science discourse through WebCT.

WebCT for Science Discourse

The WebCT discussion tool enabled students and teachers to carry out interactive dialogue through posting of messages under various discussion topics, which were threaded. Some class time was dedicated for WebCT dialogues. Students were also able to access WebCT during certain lunch periods and from their homes (more than 90% of students had Internet access and hence access to WebCT from home). Below in Table 3, is an example of teacher posting:

Table 2. Example of Teacher Posting

Message no. 212: posted by ST_Benedict Sun Mar 04, 2001 16:20 Think about the demonstration that was performed in class with food coloring and water. Then write your theories to explain what happened during the demonstration. Write your theories with particle theory of matter in mind. You should also use the following questions as a guide when writing your theories. 1. What is happening in beakers? 2. What did you observe? 3. What were the differences and similarities in the behavior between the contents of the two beakers? 4. Explain the difference in behavior using the particle theory of matter? What is happening to the particles? 5. Why is there a difference in the behavior? 6. What is causing the difference in behavior? 7. What can we conclude about the behavior of particles from this demonstration?

DATA COLLECTION AND ANALYSIS

The primary method of data collection for the research reported in this paper involved the gathering of students' WebCT posting. Student postings were read and classified using Walton's (1996) argumentation schemes for presumptive reasoning. Not all student postings were argumentative, and, therefore, not all postings had the required characteristics needed to satisfy Walton's schemes. In looking for dialogues that satisfied Walton's schemes, it was apparent that some schemes were represented more frequently than others and yet some other schemes were not represented at all.

DISCUSSION OF FINDINGS

We first illustrate students' collective presumptive reasoning and then discuss in detail "argument from sign" to demonstrate how Walton's schemes may be used to structure, interpret, and evaluate student dialogue for it's argumentative strength and validity.

Students' Presumptive Reasoning

Only five of the 12 argumentation schemes that were evident in student's WebCT postings are outlined below in Table 3, with general description of scheme, the frequency of evidence for these schemes, and sample postings that represent the schemes:

Table 3. Argumentation Schemes

Argument from Sign (n=45) *A particular finding or observation x is taken as evidence of the existence of a property or event E, in a given situation.* Message no. 252: [Branch from no. 212] posted by 567832 on Mon Mar 05, 2001 15:13 Subject: re: Colored Water …the colouring spread in the water. Beaker B had the hot water. i could tell because there was condensation at the top and the colouring spread through much faster. the particals moved much faster and they spread apart….
Argument from Cause to Effect (n=25) *The argument from cause to effect takes the form of a prediction or warning that one type of event tends to cause another. Generally, if A occurs, then B will (or might) occur. In this case, A occurs (or might occur). Therefore, in this case, B will occur (or might occur).* Message no. 250: [Branch from no. 212] posted by 231421 on Mon Mar 05, 2001 15:11 Subject: re: Colored Water The differences were that the beaker with hot water in it made the food coloring spread faster and the beaker with the cold water in it was spreading slower and less evenly
Argument from Evidence to Hypothesis (n=22) *This type of argumentation is typical of experimental verification or falsification of a hypothesis in scientific reasoning. Argument from evidence to a hypothesis takes two basic forms, or argumentation schemes, one of which is positive and the other negative. The positive form, called <u>argument from verification of a hypothesis</u>, has the following argumentation scheme. If A (a hypothesis) is true, then B (a proposition reporting an event) will be observed to be true. B has been observed to be true, in a given instance Therefore, A is true.* Message no. 221: [Branch from no. 213] posted by 756369 on Mon Mar 05, 2001 09:52 Subject: re: Colored Water In the beakers before the colour was added beaker a had cold water and beaker b had hot water. When the color was added the reason beaker b was spread out faster but not faster to the bottom was because the water particles were moving faster. Therefore it spread faster, as it was spread out by the fast-moving water particles. In the cold water, the food coloring sank to the bottom quickly but was not spread out as fast.

The particles are moving at different speeds (though always moving) They spread the food colouring at different rates, depending on their speed (which is controlled by the temperature of the water, the reason for the difference in behavior.) The particles of both substances intermingle, seemingly making blue water. Finally, we can conclude that temperature can change the speed of particles and the rate at which they intermingle.

Argument from Position to Know (n=14)

One party has reason to presume that another party has access to information or knowledge that the first party does not have direct access to. Therefore, when the second party gives his or her opinion, the first party treats the statement given as having a weight of presumption in favor of its being true, and may recommend it to others on that basis.

Message no. 186: posted by 376457 on Mon Feb 26, 2001 20:28
Subject: Grade 7>>> What is the Particle Theory of Matter??????
Particles are in constant motion. Their motion depends on the energy they have. Losing or gaining energy, particles move slower and closer together. Generally, as matter is heated the volume increases and as matter is cooled the volume decreases.

Argument from Expert Opinion (n=9)

One party attempts to support one of his or her contention to the other by saying: "This proposition is said to be rue by an expert."

Message no. 300: [Branch from no. 160] posted by 756369 on Mon Mar 05, 2001 20:04
Subject: re: air
That experiment (weighing a ballon filled with air then subtract the weight of a balloon) would only find the weight wouldn't it? what about the mass? Air's mass is in one of the sample grade eight text books.

Based on the nature and circumstance for argument, Walton's schemes observed in this study were grouped into three categories: experiential, referential, and provisional.

The "experiential" category, which represents argument from sign (n=45), argument from cause to effect (n=25), and argument from evidence to hypothesis (n=22) had the most frequent occurrences in student postings. Experiential includes argumentation schemes that are based on observation using the human senses. In the teaching of the unit on the particle theory of matter, demonstrations, investigations, and laboratory activities were frequently used to explore student ideas and "construct and negotiate" meaning. As a result of these hands-on experiences and observations, students were able to carry out an argumentative dialogue through WebCT, incorporating Walton's argumentation schemes within the first category. Students were able to discuss their conceptions of a particular event observed in the laboratory, give possible reasons for the events, and provide validation of their conceptions and reasons through WebCT conversations. In doing this, students substantiated their arguments with their experiences.

The "referential" category composed of argument from position to know (n=14), argument from expert opinion (n=9), argument from example (n=6), argument from analogy (n=4), and argument from consequences (n=3) had a mid range frequency. Hence, argumentation schemes were used by students who did not directly support their argument to their laboratory experience. These students, instead, used non-direct references, such as text, expert, teacher, and other sources. These students referred to their laboratory experiences in a non-committal manner, with reluctance and ambiguity. This shows that these students' laboratory experience did not convince them fully in the particular science concept that was under inquiry to cause complete concept shift, hence their reference to other sources for supporting their arguments.

The provisional category consisting of argument from precedent (n-2), circumstantial argument (n=1), argument from commitment (n=1), and argument from waste (n=1) had the least frequent occurrences in student postings. This category represents students building arguments with little or no substantiation. In these arguments the burden of proof can be shifted back to the original arguer with quite ease. Arguments belonging to this category, in the framework of science knowledge building by students, are the weakest of the schemes observed in the study.

Argument from sign, in the experiential category is discussed in detail below with student examples to better understand how Walton's schemes can be used as an analytical tool to study student argumentation in scientific of inquiry and knowledge building. In analyzing the nature of argumentation, Walton's critical questions for each scheme will also be used to validate the strength of the argument.

Argument from Sign

Argument from sign was observed at least 45 times on WebCT dialogues. Argument from sign is a common, simple and everyday form of arguing. In argument from sign, an observation or a particular finding is taken as evidence for existence of an event or property (Walton, 1996). Students used this scheme extensively to provide evidence for their arguments. Students used their observations in the laboratory as evidence for an event or property. Students used arguments from sign for simple and for relatively complex arguments. Three examples about argument from sign are discussed below.

Message no. 394, *"The salt increased the boiling point of water because the salt itself had a higher boiling point"* resulted from a laboratory activity that the students performed where they compared boiling points of pure water and salt water. Walton's "argument from sign" can be discerned in the above statement because of the evidence of a sign and an event related to the sign. In this statement the sign of increased boiling point is evidence to the effect of adding salt to water. This was a simple example in which an observed sign of increased boiling point was related to the event associated with the adding salt to water.

Note a variation of the above example in message no. 252: "the colouring spread in the water. Beaker B had the hot water. I could tell because there was condensation at the top and the colouring spread through much faster." The demonstration that the student is referring to in his argument was performed to show that particles move faster in hot water compared to cold water. The teacher had two beakers, one with cold water and the other with hot water. Then the teacher added food coloring to both the beakers at the same time and asked students to make observations and think about the reasons for the behavior of food coloring in the two beakers. The teacher also did not provide any information to the students about the relative temperatures of the water in the beakers.

In the above statement, we see not one but three examples of argument from sign. However, unlike the example for this, in which a sign yields one conclusion, here, three signs yield two different but related conclusions. In addition, two of the three possible signs yield the same conclusion, thus making the argument stronger. The student uses the sign of "*condensation at the top*" of the beaker as evidence for hot water. The student is then able to use the evidence of hot water as a sign for the event of color spreading through much faster than the other beaker. The student may have also used the faster spreading of food coloring as a sign for evidence of hot water as well. We can see that the student may have used two signs, which lead to the same event or property. Sign of condensation and the sign of faster spreading of food coloring can both be presumed to signify the presence of hot water.

Consider yet another example, which is more sophisticated than the previous two examples. As part of a class activity, students were given samples of molasses, water, and oil. They were asked to pour these liquids into a beaker and make observations. Then they were asked to post their theories for their observations on WebCT for their classmates to read and discuss. Message no. 405 states. *"The molasses sank to the bottom because it is the most dense because it is the thickest meaning its particles are closer together or in some cases even heavier. The water stayed in the middle because its not the lightest like* *the oil and not the heaviest like the molasses, its density is like the average of the both. The oil rose to the top because its particles are further apart then all of them and it's the lightest substance."* Compared to the first two examples, this message is more sophisticated. The message contains several interrelated signs and events: (a) The sinking of molasses is seen as a sign for evidence of molasses being the heaviest of the three liquids; (b) The sinking of the molasses is seen as a sign for evidence of molasses being the densest of the three liquids; (c) The sinking of the molasses is seen as a sign for evidence of molasses being the thickest of the three liquids; (d) The sinking of the molasses is seen as a sign for evidence of molasses particles being closer together than the other two liquids; (e) The thickness (viscosity) of the molasses is seen as a sign for evidence of molasses being the densest of the three liquid; (f) The thickness (viscosity) of the molasses is seen as a sign for evidence of molasses having particles closer together; (g) The thickness (viscosity) of the molasses is seen as a sign for evidence of molasses having heavier particles than the other two liquids; (h) The thickness (viscosity) of the molasses is seen as a sign for evidence of molasses being able to sink to the bottom; (I) The sign of water staying in the middle was used as evidence for water being lighter than molasses; (J) The sign of water staying in the middle was used as evidence for water having a density less than molasses; (k) The sign of water staying in the middle was used as evidence for water being heavier than oil; (l) The sign of water staying in the middle was used as evidence for water having a density more than oil; (m) The sign of oil rising up was used as evidence for oil particles being further apart than the rest of the liquids; and (n) The sign of oil rising up was used as evidence for oil being the lightest of the three liquids. Even though at first the student's statement may have been seen as simple, we were able to extract 14 signs and relate them to their corresponding events or properties. The sophistication and the intricacy of arguments presented by the student as evidence for her observation are apparent. We see that several different signs are used as evidence for the same conclusion (examine a & g; b & e; and d & f). We can also see that same signs are used to reach different conclusions (examine a, b, c, & d; e, f, g, & h; i, j, k, & l; m & n). The degree of sophistication can vary from one statement to the next even within the same argumentation scheme. By relating signs to conclusions in numerous ways, this student had made the argument strongest and the most sophisticated of the three examples shown.

Walton (1996) calls the types of arguments presented in the last two examples of student statements, evidence accumulating arguments. Evidence accumulating arguments are represented by a sequence of signs, each of which only gives a small weight of presumption for the conclusion, but taken together represents a stronger argument. The students' use of two or more signs, instead of using one sign to reach their conclusions has possibly made their argument stronger amongst their peers.

So far we have seen three good examples of Walton's argument from sign. We also know that arguments that become classified according to Walton's schemes are presumptive in nature, that is that weak arguments can be allowed to be valid until it is proven invalid or until the burden of proof is shifted back to the arguer. So how does one shift the burden of proof or how does one validate the strength of an argument? Walton (1996) has included critical questions for each of his argumentation schemes to validate the strength of the argument. For evaluating the argument from sign scheme Walton has prescribed with the help of Hastings, two critical questions. (1) *What is the strength of the correlation of the sign with the event signified? (2) Are there other events that would more reliably account for the sign?*

The three examples of arguments from sign presented above have high correlation between the sign and the event signified. There are also no other events that would reliably account for the sign in the context of the activities performed by the students. Therefore we can presume with a high degree of confidence that the arguments presented by the students are indeed reasonable and plausible. However, message no. 229 states: *"In the beaker with the hot water the food coloring expanded more slower, and evenly. For the cold water the food coloring expanded faster, and spreaded out more."* In this example the sign of hot water is associated with the event of food coloring spreading out slower and the sign of cold water is associated with the event of food coloring spreading faster. Even though this argument may seem valid at face value, if the two critical questions suggested by Walton were used for evaluating the strength of this argument, we will see that that the argument soon falls apart. The fist question has to do with correlation of sign and the event. Hastings (1963) states that the strength of the argument from sign depends on the strength of the causal relation between sign and event. In our example we see that there is no correlation between hot water and decreased speed in the spreading of food coloring. The second critical question asks other events which could more reliably account for the sign. The sign of hot water is more accurately associated with food coloring spreading faster and the sign of cold water is more accurately associated with slower spreading of food coloring. So there is an alternative, more plausible explanation for the observed event.

IMPLICATION: DEVELOPING ARGUMENTATIVE SKILLS IN THE SCIENCE CLASS

Students have used argumentation even though they were presumptive in nature, in the dialogues with their peers and with teachers, without the teacher explicitly directing them to use argumentation in their conversations. Argumentation is not a natural process, even if it may seem so when we see the students exhibiting argumentative practice in their dialogues. The students must have learned from somewhere how to carry out an argumentative dialogue so that the burden of proof is shifted away from them. However, argumentation in every day life is different from argumentation in the context of exploring and building theories. Every day life argumentation is a good start for introducing the students to the concept of argumentation. But it cannot be the final stage on the concept of argumentation. We have seen that students have used every day type of argumentation in talking science. While this may be valid, teachers should guide their students to continuously refine their argumentation. Several science educators (Driver, Newton, & Osborne, 2000; Ebenezer & Richard, 2000; Jimenez-Aléixandre, Bugallo-Rodríguez, & Duschl, 2000; Duschl, Ellenbogen & Erduran, 1999; Kuhn, 1993) and philosophers (Toulmin, 1958; Siegel, 1995, Walton, 1996) have described the merits of developing argumentative skills of students to carry out rich dialectical argumentation.

Children come to class with their own experiences and conceptions and as far as they are concerned the burden of proof lies now within the teacher (rhetorical). The teacher has the responsibility to shift the burden of proof from the teacher to the student. For dialectical argumentation, science classrooms need to offer opportunities for students to articulate reasons for supporting a particular claim, to attempt to persuade or convince their peers, to express doubts, to ask questions, to relate alternative views, and to point out what is not known (Driver, Newton, & Osborne, 2000). With this knowledge of argumentative practice, the burden of proof can be shifted to the students, where now the responsibility lies within them to argue for their ideas and conceptions (dialectical). In using argumentation, students also not only learn to validate and strengthen arguments by asking questions similar to Walton's critical questions, they also learn to shift the burden of proof away from them. Students also learn to critically examine other students' arguments by asking critical questions, which makes a student to shift the burden of proof to the other student. Then the responsibility lies within that student to prove his or her argument to be valid. Being able to present coherent arguments and evaluate others is important if students are to understand the basis of the knowledge claims with which they are confronted. They will be able argue for their beliefs and theories adequately, now knowing the rules of argument, and they will also be able to ask proper questions to validate their own arguments and other people's arguments as well. Overall, they will be able to critically examine and analyze the information that is presented to them. Argumentation and the analysis of it become powerful tools for instruction when used appropriately. Argumentation analysis will also provide teachers with a way to identify features of discussions that they want to encourage students to use or avoid to advance individual students' critical reasoning ability.

The Common Knowledge Construction model employed in this study has shown to be a useful model in promoting argumentation in the science classroom. As the common knowledge construction model prescribes, the exploring and categorizing of students' knowledge facilitated appropriate lesson sequencing based on students' ideas. We made the students come to consciously realize their theories and thoughts on science phenomenon. Students then, through scientific inquiry (research, experimentation, discussion, finding evidence etc.), tested the validity of their theories and thoughts in a social setting. This was the beginning of the constructing and negotiating phase of the common knowledge construction model. Through further scientific inquiry in a science community setting, most students were able to construct new knowledge. The process of leaving the old, and constructing new knowledge was evident in the argumentative dialogues took that place on the WebCT platform. The common knowledge construction model provided the students the necessary tools for argumentation to occur. Through the experience of the Common Knowledge Construction model students not only had the opportunity to learn about science concepts, but also were given some insight into the practices and methods of science, and its nature as a social practice. Students were inaugurated into the epistemology of science for building theory—a goal in science education.

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