Effects of On-line Collaborative Argumentation Processes on Justifications

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Abstract: Justifications (through evidence or explanations) are central to productive argumentation. This study examines how the participant structures and discourse moves of students engaged in collaborative learning affect their justifications. Forty students working on Knowledge Forum, an on-line collaborative learning environment, posted 136 messages, which were coded and analyzed with an ordered logit,vector autoregression, system of equations. When students disagreed or made claims, they were more likely to use evidence. After a student made an alternative claim, the next student posting a message was less likely to use evidence. When students made claims, disagreed, disagreed with other's justifications, or read more notes, they were more likely to use explanations. Boys made more claims than girls did, but otherwise, they did not differ significantly in their likelihood of using justification. Together, these results suggest that participant structures and discourse moves are linked to justifications.

Introduction

During argumentation, students can construct knowledge through their use of justifications to support their claims and evaluations (Lipponen, 2000; Saab, van Joolingen, & van Hout-Wolters, 2005; van Amelsvoort, Andriessen, & Kanselaar, 2007). The quality of their justifications depends on their evidence, their explanations (Clark & Sampson, 2008; Hakkarainen, 2003; Weinberger & Fischer, 2006), and the complexity of their reasoning (Hmelo-Silver & Barrows, 2008). Since justification is a critical activity while constructing knowledge, the way in which individual learners use justifications to construct claims is an important issue (Kuhn, 2001). This is especially true in online environments (Weinberger & Fischer, 2006) which can facilitate the construction of justified claims by providing learners with more time to formulate arguments (Marttunen & Laurinen, 2001); in contrast, learners rarely constructed justified claims on their own in individual argumentation due to time limitations (Kuhn, 1991).

This study focuses on messages posted on an electronic forum by students in a secondary school geography class. The students were discussing possible solutions to problems associated with global warming. The study investigated how the discourse moves of the students and the resulting participant structures affected the justifications they made during the online discussion.

Theoretical framework

Collaborative Argumentation and Knowledge Construction

Traditional theories of argumentation have often focused exclusively on the various stages of argumentation (Kuhn, 2001; Toulmin, 1958). Overly restrictive, they regard arguments as essentially a means to winning, overlooking its highly interactive nature. When students participate in collaborative learning, however, they typically argue to learn rather than to win. More recent approaches to argumentation have introduced the idea of *interactive argumentation*, which is defined as a social and collaborative process directed at articulating informal reasoning (Perkins, Farady, & Bushey, 1991) and constructing and advancing knowledge (Duschl & Osborne, 2002), rather than only justifying or refuting particular points of view (Van Eemeren, Grootendorst, & Snoeck Henkemans, 2002).

As a collaborative learning format, knowledge construction has shown that learners can engage in diverse forms of interactive argumentation to advance shared understandings (van Boxtel, van der Linden, & Kanselaar, 2000). The activities involved in constructing knowledge include sharing, shaping, modifying, restructuring and

abandoning knowledge; all of which are both cognitive and socio-cultural. Thus, learners need environments in which they can discuss, share, evaluate, justify, and debate.

Researchers have found that learners use evidence and explanations during argumentation differently (Brem & Rips, 2000; Kuhn, 2001). For instance, Kuhn (2001) found that young children failed to differentiate between evidence and explanations, but their ability to do so increased as they grew older. Brem and Rips (Brem & Rips, 2000) found that learners could differentiate between explanations and evidence but still preferred explanations over evidence due to social and pragmatic factors. What determines the preference for explanation or evidence during argumentation? One view is that it is determined by "personal characteristics, or a person's epistemological beliefs concerning the way knowledge may be justified, and the different roles of evidence and theoretical explanation in the construction of knowledge" (Glassner, Weinstoc, & Neuman, 2005, p. 107). Moreover, the availability and strength of evidence also determines how students use it to justify arguments (Brem & Rips, 2000; Kuhn, 2001). During argumentation, if students are provided with evidence, they tend to use it. Otherwise, they tend to use explanations (Brem & Rips, 2000).

Although many studies have shown that giving evidence and explanations to justify arguments is involved in constructing knowledge, most have focused on individual rather than collaborative argumentation. Do discourse moves, such as questions, claims, and evaluations influence types of justification? Do the characteristics of learners influence the types of justification they use? The next section focuses on discourse perspectives on interactive argumentation and their relation to discourse quality.

Discourse Moves, Participant Structures and Justifications

To examine how collaborative construction of knowledge occurs through constructive argumentation, consider two central elements: discourse moves and participant structure (Hmelo-Silver & Barrows, 2008).

Discourse moves are used here as units of analysis for investigating the socio-cultural contexts in which the cognitive processes of argumentation, such as justifications, are embedded. Discourse moves, whether written or spoken, typically involve one participant addressing one or more participants and are characterized by their communicative functions (Tapper, 1996). For instance, Hmelo-Silver and Barrows (2008) identify questions, statements, and regulations as three important discourse moves in knowledge building discourse. Thus, the discourse moves that online learners use to justify arguments often elicit further discourse moves by other students.

Question types are related to the use of evidence and explanations during collaborative knowledge construction. The presence and nature of questions in the online discourse have been used as indicators for the level of knowledge construction. Hakkarainen (1998) classified questions into factual-oriented and explanation-oriented questions, specifying that the former should yield evidence, while the latter should yield explanations (Kuhn & Pearsall, 2000). Making claims and evaluating different points of view are important discourse moves in argumentative discourse and are essential in the productive construction of knowledge. Participants make claims and evaluations to express and examine diverse perspectives, and to negotiate shared understandings in light of prior knowledge and new information (Andriessen, Baker, & Suthers, 2003; Teasley & Roschelle, 1993; Veerman, 2003).

Evaluations include full agreements, full disagreements and partial disagreements. To minimize conflicts, students typically express disagreements diplomatically through polite disagreements (Holtgraves, 1997) or unstated partial agreements and partial disagreements (Pomerantz, 1984). Based on research on face-to-face conversations, Pomerantz (1984) found that very often, agreements are preferred during conversation. Consequently, respondents usually preface a disagreement with an agreement ("Yes, … but…"). This type of partial agree/disagreement organization is often used to disagree. We will explore how evaluations affect justification in online discourse in this study.

Few studies have examined the relationship between discourse moves and types of justification. A preliminary descriptive study showed that in a collaborative learning environment, learners tend to present evidence and explanations when responding to disagreements while they tend to present more explanations when supporting claims (Clark & Sampson, 2008). However, researchers have not systematically tested explanatory models of how discourse moves or participant structures predict subsequent justifications (explanation or evidence).

The rise of collaborative learning has deepened awareness that the cognitive processes of learning are rooted in and grow out of socio-cultural processes. These include complex structures of participation by which learners constitute and are in turn constituted by communities of practice (Lave & Wenger, 1991). The notion of participant structure was originally characterized as the ways in which teachers arrange "verbal interactions with students, for communicating different types of educational material, and for providing variation in the presentation of the same material" (Phillips, 1972, p. 377).

The definition of participant structure focuses mainly on students' involvement or engagement, which was usually qualitatively defined or described. Participant structures in computer-supported collaborative knowledge building discourse can be represented by means of social network analysis (SNA) which can measure both reading and writing behavior (Zhang, Scardamalia, Reeve, & Messina, in press). SNA represents social networks in the form of directed graphs composed of nodes representing people, and links representing people reading or responding to the messages of other participants. Online participants may write messages that build on the messages of other participants or read messages of other participants. The positions of participants social network are based on their connections to other network participants. Researchers have also suggested that the use of evidence or explanations are also affected by learning contexts and learner characteristics (Brem & Rips, 2000). We will also explore them in this study.

This study explores the use of discourse moves and participant structures to predict two kinds of justification (giving evidence and explanations) in online argumentative discussions. Specifically, it focuses on the following four questions: 1. Are general features, such as participants' gender, age, and topics related to types of justification? 2. Are participant structures related to types of justification? Specifically, do participants with different importance to the network tend to produce different justifications? 3. Are discourse moves related to types of justification? E.g., will participants generally use more explanations when making claims or giving evaluation? Do different forms of disagreement involve different types of justification? 4. Can discourse moves predict types of justification of subsequent notes? E.g., can questions, claims and disagreements in earlier messages be used to predict types of justification in later messages?

Methodology

Data Sources

This study analyzes the online discourse of students in a secondary school in Hong Kong. For one semester, 40 Form Three students in the humanities course used Knowledge Forum (KF^{TM}) (Scardamalis, 2004), an online learning environment to support discussions. The teacher had students discuss energy problems from a number of perspectives. Two topics that had provoked sustained discussion were selected for study. One topic "The Energy Crisis," elicited 82 postings and the other topic, "There are More Advantages than Disadvantages for China Developing Nuclear Energy," garnered 54 postings.

Coding Schema

Utterances were coded separately for discourse moves and types of justifications. Difference levels of coding are applied for discourse moves. First, utterances are coded as claims, evaluations, questions, and information. Claims, evaluations, and information are exclusive codes. Questions are coded separately. Thus, an utterance coded as a claim, evaluation, or information may also be coded as a question. Claims may be new claims or alternative claims. Evaluation may be agreement, disagreement, agreement plus justification or disagreement plus justification. Questions may be fact-oriented and explanation-oriented.

This study examined quality of argumentation by focusing on types of justification: evidence and explanation in order to identify the extent to which students use them as warrants for claims or evaluations on others' message. Explanations involve reasoning in justification but have no empirical data, personal experience, or references to an authority, e.g., "I don't agree with your opinion because I think wind and hydro power are more environmental than coal and oil resources". Evidence involves empirical data, personal experience, or references to an authority, e.g., "I don't agree with you that there is no danger of nuclear power. The Chernoby Nuclear Power explosion at Ukrainian in 1989 is an example". Notes that only have evidence are assigned 1 for evidence, and 0 for explanation. Notes that only have explanation are assigned 0 for evidence, and 1 for explanation. Notes that include both evidence and explanation are assigned 1s for both evidence and explanation, and notes with neither evidence nor explanation are assigned 0s for both evidence and explanation. Coding was first done by the first author and then recoded blindly by a research assistant. The inter-rater reliability, measured via agreement percentage ranged from a low of 79% (claim) to a high of 94% (question).

Various indicators were used to examine the participant structures of social networks (centrality, density) and the positions of members (frequent responders with high outdegrees vs. popular members with high indegrees, betweenness) in networks. Betweenness measured the extent of brokers' importance between two actors connected with him. Participants with high betweenness have more control over conversations.

Analysis

Statistical analyses of group processes at the speaker turn level must overcome three difficulties. First, the outcome variable is discrete, not continuous. Second, events are often similar to recent events in time-series data (serial correlation). Third, modeling justifications requires modeling multiple outcome variables (explanation and evidence). We addressed these difficulties by using an ordered logit, vector autoregression (VAR, Kennedy, 2004), seemingly unrelated regression (SUR) systems of equations (Goldstein, 1995). We entered the variables according to time constraints, expected causal relationships, and likely importance.

$$\pi_{iy} = P(Y_{iy} = 1) = 1 / \{1 + \exp[-(\beta_{0y} + e_{iy})]\} \quad (1)$$

β_{0y} are the grand mean intercepts Y_{iy}, of speaker turn i for each outcome variable y (Evidence and Explanation). The residuals are e_{iy}.

$$\pi_{iy} = 1 / \{1 + \exp[-(\beta_{0y} + e_{iy} + \beta_{vy}\mathbf{V}_{iy} + \beta_{wy}\mathbf{W}_{iy} + \beta_{xy}\mathbf{X}_{iy} + \beta_{zy}\mathbf{Z}_{iy})]\} \quad (2)$$

First, we entered a vector of v speaker background variables: topic, age, gender, total number of messages, SNA aspects, such as degreeness, closeness, and betweenness of reading and building on others' notes ($\mathbf{V}$). A nested hypothesis test (χ^2 log likelihood) indicated whether each set of explanatory variables was significant (Kennedy, 2004). Non-significant variables were removed. Then, we entered a vector of turn property variables: disagree, polite disagree, disagree against justification, a claim, extended claim, question, interpret question ($\mathbf{W}$). Next, we tested for the property of the previous turns. We entered lag 1 – lag 4 variables of the above turn property variables ($\mathbf{X}$). To test for moderation effects, we added interactions among significant variables ($\mathbf{Z}$).
An alpha level of .05 was used.

Results

Test and Summary Statistics

Of the 136 messages, 134 were coded using our coding scheme. Of the two remaining notes, one was blank, which we assumed was a system error. The other was an off-task comment and since it was the only one in the data set, we ignored it. Among the 134 notes, three were composed by the teacher, and 115 notes were coded as evaluations or claims. 16% of them were coded as having neither evidence nor explanation, 40% as having explanations only, 17% as having evidence only, and 27% as having both. 51% of the messages were posed by girls. Disagreements occurred in 25% of the messages. Also, justifications occured more often during disagreements than during agreements. During both agreements and disagreements, explanations occurred more often than evidence use. People also used justifications more when making a claim than when evaluating a claim. Please refer Figure 1 about the effects of discourse moves and participant structure variables on evidence and explanation.

Explanatory model

Predict Evidence

Boys were 33% more likely to express their ideas with evidence than girls. Girls were 13% less likely to make claims (Sobel $z = -1.97$). Taking into account the likelihood of making new claims, girls' and boys' use of evidence do not differ significantly.

When learners disagreed, they were more likely to invite evidence. A disagreement in the current turn was 39% more likely to have evidence. When learners made a claim, they preferred to use evidence. Controlling for claims in current turns, the gender effect on evidence was reduced by 30%.

Alternative claims in the previous turn yielded 8% less evidence in the current turn. When a previous learner Made an alternative claim, the next learner was 41% less likely to use evidence. The gender effect on evidence no longer significantly controlled for alternative claims in previous turns. Other variables were not significant (e.g., discussion topic).

Predict Explanation

Those who read more notes by other people were more likely to use explanations when expressing their ideas.

Disagreements in current turns were 78% more likely to have explanation. Current turns' disagreements against justification were 78% more likely to have explanation. Moreover, claims in current turns were 61% more likely to have explanation. Other variables were not significant (e.g., discussion topic).

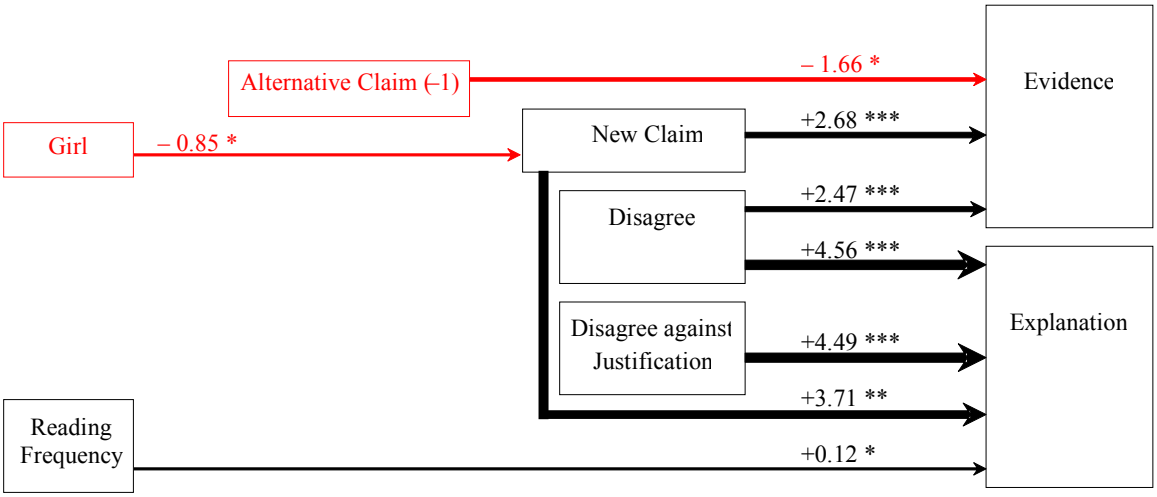

Figure 1: Path diagram of the final multivariate logit regression model predicting Evidence and Explanation. Black lines and boxes indicate positive links. Red lines and boxes indicate negative links. Thicker lines indicate larger links.

Discussion

This study found that gender, disagreements, claims, and alternative claims can predict the use of evidence. Claims, disagreements, disagreements against justification, and students' reading frequencies are linked to the use of explanations. Messages with alternative claims yielded subsequent notes with fewer explanations.

Boys tended to use more evidence than girls in justification because they made more new claims than girls did. Taking into account the number of claims, the likelihood of evidence use did not differ significantly among boys and girls. Previous studies found that males engaged in more and longer online discussions than females, and that males tended to engage in greater levels of social exchange than females (Barrett & Lally, 1999). Females were also found to make fewer qualified arguments than males (Meyers, Brashers, Winston, & Grob, 1997). However, past studies of gender differences did not differentiate evidence vs. explanations in argumentation. Girls preferred to evaluate the opinions of others or to add their own opinions to new claims. Encouraging girls to make new claims or to state new opinions might lead to their greater use of evidence.

Participants who read more messages by others were more likely to produce explanations, possibly because they acquired more information from others to use for their explanations. In addition, reading messages from others might also help them recognize the potent impact of justifications (e.g., to persuade others to agree, e.g. Chiu, & Khoo, 2003). In contrast, participant centrality (brokerage positions) did not correlate with types of justification. The fact that brokerage positions were not related to discourse moves may indicate that such positions in online social networks do not function as they do in face-to-face social networks. Because learners in higher brokerage positions neither control nor have more access to resources, they did not perform differently from learners in non-brokerage positions.

When people make claims, they typically provide evidence and explanations to support them (Figure 3). For instance, when learners make claims, they might anticipate disagreements and provide justifications preemptively, and thereby be more persuasive (Chiu & Khoo, 2003). Disagreements are also often accompanied by evidence and explanations (especially compared with agreements) because when learners challenge each others' ideas, they are more likely to provide evidence or explanations for persuasion than when they agree with them. This finding is consistent with Clark and Sampson's (2008) study of online discussions of science issues. Furthermore, when learners challenge the validity of evidence or explanations offered for claims or evaluations, they are much more likely to use explanations than when they challenge theses (Clark & Sampson, 2008; Erduran, Simon, & Osborne, 2004). This differs from disagreeing with theses that do not attack the evidence or explanations. Learners

use their own explanations to undermine the beliefs of other and to justify their own opinions. The preference for explanations over evidence is consistent with previous claims that learners tend to use explanations in arguments (Kuhn, 2001) and is sensitive to goals (Glassner, et al., 2005; Schwarz & Glassner, 2003) which in this case involves disagreeing with something rather than proving it.

Alternative claims provide new interpretations of problematic phenomena. They are claims that differ from earlier claims but do not disagree with a specific aspect of the earlier claim. Unlike notes disagreeing with justifications or with claims, notes containing alternative claims do not contain such explicit discrepancies. The example in the results section shows that after student B's first alternative claim, student C provided a second alternative claim without evidence. It could be that people do not recognize the conflict between original and alternative claims, and without the conflict, people are less likely to use evidence after alternative claims. It could also be that because there was no strong connection between the alternative claim and the preceding message, student C was unable to follow the argument and thus was unable to provide a simple agreement or another alternative claim.

This study has theoretical, methodological and practical implications for researchers and practitioners. Theoretically, it suggests that discourse moves and participant structure might influence the use of justifications. It provides evidence that cognitive and social communicative processes are closely related and integrated in the online discourse activities. Methodologically, this study used quantitative methods to analyze messages in an online forum, traditionally viewed as qualitative discourse data. It used ordered logit, vector autoregression, systems of equations to analyze relationships among the multiple dimensions of online discourse thus modeling the discrete outcome variables and the relationships among the messages. More practically, the findings provide teachers with information for understanding and managing online discussions. Teachers usually have difficulty examining students' online discussions in detail and providing them with useful feedback. If these results are validated in future studies, then teachers can encourage students to read each others' notes to collect information and develop their skills in providing justifications.

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