AppleTree: An Assessment-Oriented Framework for Collaboration and Argumentation

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Abstract: In this paper, we articulate a framework (called AppleTree) for assessing collaborative argumentation with the purpose of evaluating and empowering the development of argumentation skills, collaboration skills and content knowledge in school learning. The framework is motivated by the need to achieve "learning to argue" and "arguing to learn" and the necessity to embed on-going and automated formative assessments for collaborative learning as reflected in existing literature. It builds on existing systems for collaborative argumentation and automated assessment of collaborative learning to achieve assessment for learning and to realize it in authentic classroom environments. We illustrate the framework by instantiating it in the conceptual design of one such system for use in schools.

Introduction

Understanding the significance of both "learning to argue" and "arguing to learn" (Scheuer, et al., 2010), Computer-Supported Collaborative Learning (CSCL) researchers have developed many computer-based systems to support argumentation in the collaborative fashion, to facilitate communication and argumentation between multiple participants (Scheuer, et al., 2010). A typical problem with the use of such systems is the low level of participation and interactivity in online learning environments. One way to foster productive collaboration is to empower regulation (i.e., supporting collaboration by taking actions "on the fly" to enable immediate adaptations when unexpected events occur during interaction, Dillenbourg & Tchounikine, 2007). Regulation is a complex skill depending on a quick appraisal of the current interaction situation and its compatibility with the desired (Jermann & Dillenbourg, 2008). This calls for embedding real-time assessments of collaborative learning in the system. Considering this, we conceptualized AppleTree, an assessment-oriented collaborative argumentation framework for measuring and fostering collaboration and argumentation in real classrooms. We hope AppleTree can make a difference to existing school practices via: 1) helping equipping students with 21st century skills (critical thinking and collaboration skills in particular); and 2) providing a workable approach to realize not only "assessment of learning", that is establishing what students have learnt in a summative way, but also "assessment for learning", that is using multiple forms of information about students' learning as feedback to modify the learning activities they are engaged in (Shepard, 2000). In the next few sections, we advocate the ingredients of assessment in such a framework, and propose a conceptual design of a system as an instantiation of the framework.

Ingredients of the AppleTree framework

In our assessment-oriented collaborative argumentation framework, we envisage automated assessment components that can assess both cognition development and social participation. The former is achieved through assessing the structure and validity of the represented arguments. The latter is realized through analyzing quantitative information concerning data-based usage of the system, including all the interactions involving argumentation and online-based communication. Knowledge on how participation in online environment contributes to learning is lacking (van Aalst, 2010). With the assessment components proposed, we seek to contribute to this topic by identifying good collaborative patterns that can bring about learning in domain knowledge, development in argumentation skills and improvement in communication and collaboration skills.

We propose the AppleTree framework that incorporates mechanisms for supporting formative (diagnostic) assessment of the on-going collaborative argumentation process in order to foster and enhance students' collaborative argumentation and optimize teachers' instruction. The key ingredients are:

1) It supports assessment *for* learning rather than assessment *of* learning.
2) It assesses *domain knowledge*, *argumentation skills* and *collaboration* at *individual*, *group* and *class* levels.
3) It is not only an assessment tool, but also a tool for visually representing learning processes unfolding or happening in classrooms.
4) It assesses not only the learning *outcomes* but also helps track and monitor the *process* of collaboration.
5) It involves both *self*-assessment and *peer* assessment by the students.
6) It is a *real-time* assessment tool which provides immediate feedback to teachers and students with which they can adjust or improvise teaching and/or learning, as well as 'feed forward' into future work.

In a CSCL system, if the ongoing analysis of the data is not available to teachers in real-time, it is usually too late for teachers to their adjust in-situ instruction and enactment strategies based on the assessment outcomes as the "end products". The visualization of on-going argumentation and collaboration amongst the students provides a version of a cockpit's view for the teacher to orchestrate classroom activities. AppleTree has the potential for providing teachers with the necessary information to tailor instruction to meet student needs. The feedback is intended to be less final and judgmental (Boud, 1995) but more interactive and forward-looking (Carless, 2002), timely and with a potential to be acted upon (Gibbs & Simpson, 2004), which can well facilitate teachers to enact collaborative argumentation activities to cultivate argumentation and collaboration awareness and skills in students.

Moreover, assessing students' performance in collaborative learning is not just the prerogative of the teachers. Equally, the students themselves need to understand own performances in a reflective way to help improve the productivity of their interactions. The AppleTree framework is intended to inform student learning: what learners are doing, what claims and evidences are they generating, editing, commenting or improving, what argumentative relationships they are establishing, where they are spending their time, how well they are progressing, and so on—at the individual or group level. It will inform students with regards to various aspects of argumentation and collaboration. The students have access to other groups' artifacts and assessment so that they can compare, critique and reflect. The integration of peer rating will encourage students to reflect on the learning process, to become more responsible and engaged in collaboration, so as to cultivate a collaborative culture in the long term.

An Instantiation of the Framework

To concretize the framework, we envisage a system that is conceived as a multiuser tool for developing scientific argumentation skills and collaboration skills in secondary school students (see Figure 1). Like most collaborative argumentation systems, its user interface provides students with a shared and synchronized working space for collaborative construction of arguments and a chat tool for communication and coordinating group work. A collaboration script (see following) is embedded in the system design to guide group members to do iterative cycles of intra- and inter-group interaction so as to achieve continuous knowledge improvement. Real-time visualizations and evaluations of students' social participation and argument construction at different learning stages are displayed to scaffold the argumentation processes and to inspire reflections on both individual and group work.

Argument Pattern and Representation

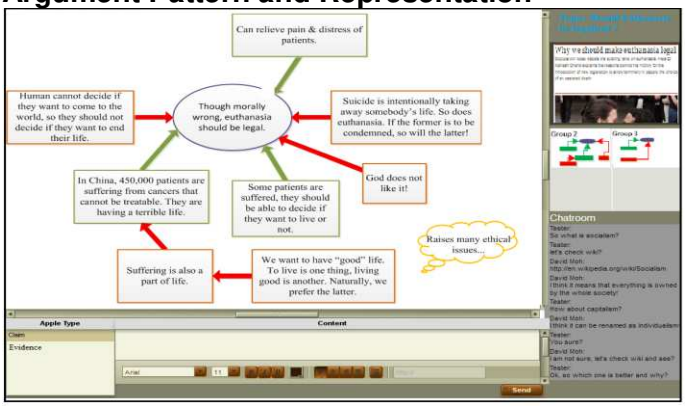


Figure 1. Screenshot of the AppleTree System

Table 1: Argument elements and examples

Argument Element	Textual representation	Graphic Representation	Example of an Argument
Claim	Claim		
Support	Evidence +For		
Rebuttal	Evidence +Against		
Placeholder			

For argumentation systems, providing an external representation to enable the creation, reviewing and modification of arguments by users is an important goal (Scheuer, Loll, & Pinkwart, 2010). An AppleTree implementation will use graphic representations, as graphic representation expresses the argument structure explicitly and is an intuitive form to model knowledge (Suthers & Hundhausen, 2001). There is the public working space in which an argument is an organized set of argument elements represented by nodes and/or directed links. The specific types of argument elements designed are in accordance with Toulmin's Argumentation Pattern (TAP) (1958), a most extensively adopted framework for both scaffolding and assessing argumentation in educational contexts (e.g. Jimenez, Rodrigues & Duschl, 2000; Mitchell, 1996). For both pragmatic considerations (e.g. understandability by the secondary school students) (Scheuer, et al., 2010) and assessment feasibility, three argument elements, namely claim, support (including data, warrant, or backing) and rebuttal are identified as the essential components of an ideal argument. On an AppleTree implementation, these three elements are indicated by: 1) the type of Node: Claim vs Evidence and/or 2) the type of directed Link: For vs Against (Table 1). Considering there are times students may come up with some idea but they cannot decide

whether it is a claim, a support or a rebuttal, we provide a bubble node with an undirected link as "placeholders" where students can record these ideas. Providing these "placeholders" is important as it can encourage brainstorming and pooling of ideas.

Scripted Collaborative Argumentation

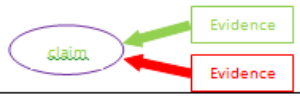
To realize constant improvement in argumentation via collaboration, an adaptive and generic script is integrated into AppleTree. Following this script, student collaborative argumentation process is composed of repeated two-staged (intra-group and inter-group) interaction episodes. At the first stage, students need to brainstorm, generate and further improve arguments within a group. When a group has agreed upon the argumentation graph created, group members are required to go to other groups' working spaces to evaluate the arguments developed. They judge whether the argument elements and links generated are valid or not by indicating whether they "Like" or "Dislike" it. Reasons for their judgment, which later can be used as constructive feedback with which the group being evaluated can use to further improve their arguments, are also to be provided. In the following episode, students go back to their own group to further improve the argumentation graph by addressing the feedback and adding the good points from other groups via further group discussion and negotiation. If time permits, a second round of inter-group evaluation can be enacted to seek greater improvement in group work.

Automated Assessment

Assessing Argumentation

AppleTree supports on-going automated analysis and evaluation of the argumentation graph. Argumentation quality is measured by "***structural completeness***" and "***content validity***" of the arguments constructed. A scheme for categorizing different levels of argument in terms of its structural completeness is embedded in AppleTree programming to enable automated analysis, visualization and comparison of collaborative argumentation graphs developed in different groups and/or at different phases of CSCL. At the conceptualization stage, based on the natural observations made of students' collaborative argumentation discourses occurred within small groups, 4 levels of arguments are identified in the coding scheme (see Table 2).

Table 2: Scheme for categorizing different levels of argumentation

Level	Description	Graphic representation (examples)
1	An argument that only contains a claim.	
2	An argument that contains a claim and support (s).	
3	An argument that contains a claim, support (s) and one rebuttal.	
4	An argument that contains a claim, support (s), and more than one rebuttal.	

Besides structural completeness, content validity is also an important facet for assessment as it not only reflects argumentation quality but also reveals students' understanding on domain knowledge. The realization of automated assessment of content validity is based on peer-rating during inter-group interaction. As described above, when having agreed on the group argumentation graph, group members shall go to other groups to evaluate the arguments developed. In peer-rating, each student will decide whether the elements proposed each is legitimate or not by selecting "Like" (valid) or "Dislike" (invalid). Thus argument content validity is indicated by the ratio between total number of "Like"s (N_L) and the total number of ratings received ("Like"s + "Dislike"s, $N_L + N_D$).

In addition to enabling automated assessment, peer-rating itself is also an important learning mechanism. Peer-rating engages students in making judgments about the performance of other students，a form of learning in which the contributions from others can be a very useful input for self-assessment. This provides an opportunity for learners themselves and their peers to understand and reflect what constitutes high-quality performance, and how the performances can be improved. It can be treated as a means for learning how to collaborate. From the aspect of domain knowledge learning, the disapproval of a certain element in the argumentation graph also unveils the conflicting understanding between students on this particular knowledge point. Through rating and commenting, individual understandings are pooled and aggregated. Students can explore these diversified thinking to form better understanding, leading to knowledge improvement. To facilitate this process, these "controversial" elements are highlighted via increasing the brightness of the graphic

representation. The ratio between the number of "Dislikes" (N_D) and the sum of "Likes" and "Dislikes" (N_L + N_D) is calculated for each argument element and then translated into the brightness of the node and link representing that element.

Assessing Social Participation

On AppleTree, social participation is assessed by taking accounts of individual participation within the group and group participation within the class community. Students' participation rates of different functional interaction as well as the centrality of interaction are important indicators for their participation level. The data consists of AppleTree log files and students' inscriptional group artifacts on the shared argumentation space. Social network analysis (SNA), a well-known approach to investigate online social participation, is embedded in AppleTree to help identifying patterns of relationship between participants and visualizing the "flow" of information/knowledge and/or other resources that are exchanged among participations (de Laat, et. al., 2007). A variety of SNA indicators are used to examine the holistic interaction patterns and the positions of individual participant in it. In AppleTree, the analysis of the social network established focuses on "***centrality***" and "***density***".

Based on SNA, graphical representations visualizing the network connections developed can be generated in AppleTree. These can be used as immediate and intuitive feedback to help teachers and students to adapt their following activities in the classroom. It offers a method for mapping group interactions, visualizing 'connectedness' and quantifying some characteristics of these processes (de Laat, et al., 2007). However, this approach cannot reflect individual/group's contribution or participation ratio. Hence, in AppleTree, apart from using SNA to reflect relations (links) among participant/small groups, the distribution of different functional actions enacted by both individuals and groups indicated by action frequency is also incorporated. Quantitative information on students/groups' contributions in the shared argument space or interactional moves through online chatting are extracted and represented in AppleTree. Teachers or students can select the parameters what they are concerned about, for instance, the number of claims created; the number of evidences provided; the number of commented received.

Conclusion and Discussion

The need for an assessment framework for ongoing collaboration is motivated by the need to inform students with regards to various aspects of argumentation and collaboration and help teachers to manage and orchestrate collaboration activities in and after the classroom learning. We propose ingredients of an assessment-oriented framework for collaborative argumentation to provide views on the ongoing social participation and the cognitive progression of the argumentation structures and content. The tools are meant to help the teacher and students to have awareness of what is going on, as well as help the students to be more reflective on their participation and their contributions. Provided with these tools and resources for assessing collaboration skills, teachers can be more cognizant of what and how collaboration skills are to be assessed – thus enabling them to be better informed on how to support the development of these collaboration skills, an important component of 21st century skills.

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