Available online at www.sciencedirect.com
ScienceDirect
Expert Systems with Applications 36 (2009) 2615–2624
Expert Systems with Applications
www.elsevier.com/locate/eswa

Developing argumentation processing agents for computer-supported collaborative learning

Chenn-Jung Huang *, Hong-Xin Chen, Chun-Hua Chen

Institute of Learning Technology, College of Science, National Hualien University of Education, Hualien 970, Taiwan

Abstract

In this study, an intelligent argumentation processing agent for computer-supported cooperative learning is proposed. Learners are first assigned to heterogeneous groups based on their learning styles questionnaire given right before the beginning of learning activities on the e-learning platform. The proposed argumentation processing agent then scrutinizes each learner's learning portfolio on e-learning platform and automatically issues feedback messages in case devious argument or abnormal behavior that is unfitted to the learners' learning style is detected. The Moodle (http://moodle.org), an open source software e-learning platform, is used to establish the cooperative learning environment for this study. The experimental results revealed that the learners benefited by the argumentation activity with the assistance of the proposed learning style aware argumentation processing agent.

Keywords: Argumentation; Conversation analysis; Text mining; Exception maximum (EM); Assessment; e-Learning; Learning style

1. Introduction

Recent researches indicated that students' ability to construct evidence based explanations in classrooms through scientific inquiry (Kuhn & Resier, 2005; National Research Council, 1996) is critical to successful science education (Lemke, 1990; Rosebery, Warren, & Conant, 1992; Schauble, Glaser, Duschl, Schulze, & John, 1995). The amount and quality of explanations from these reasoned arguments that students construct can show their understanding of science concepts. The practice of argumentation is then an essential teaching activity within science education because it can provide the opportunity to develop young students' ability to construct argument (Driver, Newton, & Osborne, 2000; Lemke, 1990; Toulmin, 1958).

The argumentation analysis issue researches on understanding the content of serial arguments, as well as analyzing the linguistic structure, determining the relationship between the preceding and following arguments, recognizing the underlying conceptual beliefs, and understanding within the comprehensive coherence of the specific topic. A complete argumentative analysis must depend on several aspects of knowledge: linguistic constraints, domain dependent, conceptual relations, and discourse structure. None of the above aspects are sufficient by themselves for a complete analysis, but they all contribute to complete analysis, especially in the situation that one aspect of information is incomplete, for instance, the beliefs of the student may be unknown, unusual or the semantic content may be ambiguous.

Most of the researches on student discourse depend heavily on Toulmin's model (Toulmin, 1958) to determine and identify the structural features of arguments, such as claims, data, warrants, backings, and qualifiers, and process argumentation in the literature. Analyzing the structure of students' arguments let us understand how students assimilate the desired practices of argumentation (Driver et al., 2000) and process the information about the structure and field of reasoning that students use when they provide arguments based on their experiences from living environment (Osborne, Erduran, & Simon, 2006; Osborne, Erduran, & Simon, 2007; Simon, Erduran, & Osborne, 2002; Simon, Osborne, & Erduran, 2004; Von Aufschnaiter et al., 2005).

* Corresponding author. Tel.: +886 38226738.
E-mail address: cjhuang@mail.nhlue.edu.tw (C.-J. Huang).

0957-4174/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.eswa.2008.01.036

Structured argumentation support environments have been built and used in scientific discourse in the literature, such as Collaboratory Notebook (Edelson, Pea, & Gomez, 1996), CaMILE (Guzdial, Turns, Rappin, & Carlson, 1995), and Knowledge Forum/CSILE (Scardamalia, Bereiter, & Lamon, 1994). They can be considered as learning environments that concerns about knowledge accumulation and development. SpeakEasy (Hoadley, Berman, & Hsi, 1995), Sensemaker (Bell et al., 1997), and BGUILE (Tabak, Smith, Sandoval, & Reiser, 1996) fall in the category of larger inquiry environments. The above mentioned online environments emphasized either on exchanging information or on constructing arguments for presentation.

Several different methods were proposed to identify the essential features of an argument and examine the structure of student arguments in small group conversations (Bell & Linn, 2000; Forman, Larreamendy-Joerns, Stein, & Brown, 1998; Kelly, Druker, & Chen, 1998). In addition to these specialized environments, basic online threaded asynchronous forums in which discussions are held have been shown to be effective in supporting classroom-based discourse as well. The assessment scheme developed in Kuhn's works (Kuhn & Resier, 2005) on informal reasoning and argumentation, and the work proposed by Osborne et al. (2007), Osborne et al. (2006), Von Aufschnaiter et al. (2005), Simon et al. (2002), Walker and Zeidler (2007) and Sadler and Zeidler (2005) related to socioscientific argumentation. Some recent researches such as (Bench-Capon, Coenen, & Orton, 1993; Gordon, 1994; Prakken, 2001) addressed issues in persuasiveness dialogues (Kraus, Sycara, & Evenchik, 1998; Parsons, Sierra, & Jennings, 1998) focused on negotiation in argumentation process, and (Hulstijn, 2000) studied formal models of dialogue. Parsons, Wooldridge, and Amgoud (2002, 2003) defined simple structures for persuasion, information seeking and inquiry dialogues and investigated their properties.

It has been proven that teaching the learners according to their learning styles could effectively assist the learners in the learning activities. Among the different learning style instruments, the Grasha–Riechmann Student Learning Style Scales (GRSLSS) is selected in this work owing to the following salient features (Grasha, 1996; Hruska-Riechmann & Grasha, 1982; Kumar, Kumar, & Smart, 2004). First, the GRSLSS is a relevant scale that addresses one of the key distinguishing features of a distance class, the relative absence of social interaction between instructor/learner and learner/learner. Second, the GRSLSS promotes a desirable learning environment by helping faculty design courses and develop sensitivity to learner needs. Third, the GRSLSS promotes understanding of learning styles in a broad context, spanning six categories. Learners possess all of six learning styles, to a greater or lesser extent, and a rationale for pursuing personal growth and development in the underutilized learning style areas is thereby provided. The six social learning styles identified by GRSLSS are the Independent, Dependent, Competitive, Collaborative, Avoidant, and Participant. The inventory is made up of 60 items, including six scales, ten items per scale. Learners are asked to judge themselves using a five-point rating scale that ranges from strongly disagreement to strongly agreement.

A brief discussion of each learning style is enumerated below.

- *Independent* students prefer independent study, self-paced instruction, and would prefer to work alone on course projects rather than with other students.
- *Dependent* learners look to the teacher and to peers as a source of guidance and prefer an authority figure to tell them what to do.
- *Competitive* learners attempt to perform better than their peers do and to receive recognition for their academic accomplishments.
- *Collaborative* learners acquire information by sharing and by cooperating with teacher and peers. They prefer lectures with small group discussions and group projects.
- *Avoidant* learners are not enthused about attending class activities and discussion.
- *Participant* learners are interested in class activities and discussion, and are eager to do as much class work as possible. They have a strong desire to meet teacher expectations.

In this work, we focus on helping students to develop the conceptual sources of knowledge with the structural constrained explanations which provide students a chance to practice the essential information expression of students' concept knowledge in arguments. Questionnaire developed by James and Gardner (Kumar et al., 2004) is used to determine students' learning styles. The proposed the online argumentation processing agent not only scaffolds the structural argumentation, automatically assesses the scientific argumentation from group argumentation discussion, but also determines the argumentation level of serial argumentative discussions and provides appropriate feedbacks that help students to enrich their concept knowledge level and argumentation skill level.

The remainder of the paper is organized as follows. Section 2 shows the details of the argumentation processing agent for e-learning. Section 3 reviews and discusses the experimental results. Conclusions and future work are given in Section 4.

2. Architecture of the proposed e-learning platform

Grouping module, curriculum support module, and argumentation processing agent are three major components in the proposed e-learning platform as shown in Fig. 1. The grouping module is used to group the learners with different learning styles according to the questionnaire of learning styles categorization designed by Kumar et al. (2004). Each learner can be classified into one of the five learning style clusters as shown in Table 1, and each group consists of five members that are selected from the five cor-