The DiaCog: A prototype tool for visualizing online dialog games' interactions

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ABSTRACT

This paper proposes and explains the design of a prototype learning tool named the DiaCog. The DiaCog visualizes dialog interactions within an online dialog game by using dynamically created cognitive maps. As a purposefully designed tool for enhancing learning effectiveness the DiaCog might be applicable to dialogs at discussion boards within a variety of online learning platforms. The most prominent instructional use of this tool refers to promoting collaborative knowledge building and critical thinking skills. Finally, this paper provides a new perceptive on utilizing visual elements and mind-maps into dialog games' interaction which may take place during the act of online learning.

Keywords: Dialog games, collaboration, critical thinking, and online learning environment.

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INTRODUCTION

Being capable of communicating effectively, convey messages, understand and be understood by others seems to be one of the critical sets of individual traits in the 21st century education. A tremendous amount of elements determine the quality of communicational process among two or more communicators. Dialog and argumentations are two aspects of communication which have drawn a significant research attention in the field of educational science. Undoubtedly, communicational proficiency based on dynamic dialog and solid arguments reflects the level of learner's collaboration skills for knowledge building and critical thinking. There is a body of theoretical and empirical studies which explore the connection between dialog and argumentation and its importance in instruction. Furthermore, a number of recent studies have focused on online learning tools which can be used to promote dialog and argumentation as part of collaboration, critical thinking and overall learning efforts.

According to Ravenscroft and colleagues (Ravenscroft, Sagar, Baur, & Oriogun, 2007) dialog games, as a method for engaging students in collaborative work aimed to support argumentation of the topics, may help learners to develop superior argumentation skills because of their mechanisms for providing well-structured interaction mechanism in dialogs. In some other works Ravenscroft and McAlister (2006a) provide empirical evidence in support of the instructional value and effectiveness of a socio-cognitive tool called InterLoc. According to these findings the InterLoc is an effective software solution for organizing, structuring and mediating educational dialogue games.

Dialog games mechanisms might be enriched by adding visual elements into dialog games using a cognitive mapping methodology. An experimental prototype research tool, the DiaCog, is designed in order to investigate the possibilities of promoting and making educational dialog games more effective. The DiaCog design enables visualizing the dialog interactions within an online dialog game.

The paper addresses the three distinctive aspects relevant to understanding the process of visualizing online dialog games' interactions. First, the role of argumentation and dialog in the process of collaborative knowledge building and developing critical thinking skills has been discussed. Second, the concept of dialog games is defined and explained in details. Finally, this paper proposes a possible design of the DiaCog online game and complementary instructional tools. As such the DiaCog tool design might be applicable to dialogs at discussion boards within different online learning platforms.

Overall, this paper may be a valuable contribution to the existing body of literature in the cross domain of online learning and developing collaborative and critical thinking skills. The present study is part of larger research efforts in developing more user friendly interface with capabilities of integration into traditional learning management systems such as BlackBoard or Moodle. Finally, this paper would be beneficial for a wide range of online learning practitioners, teachers and educational policy makers.

THE ROLE OF ARGUMENTATION AND DIALOGS IN IMPROVING SKILLS FOR COLLABORATIVE KNOWLEDGE BUILDING AND CRITICAL THINKING

The learning paradigm in the last few decades has been closely tied to two critical elements of learning in the higher educational settings: collaboration and critical thinking. As a reflection of this trend, curricula developers across a variety of academic fields strongly reinforce

integration of collaborative learning and critical thinking elements in all phases of instruction. A literature review shows that theoreticians are still seeking the most complete answer regarding collaboration and knowledge building.

Although a variety of definitions exist, which more or less explain this phenomenon from the educational standpoint, for the purpose of this study the most acceptable was the view of Keas and Mandell (2009). According to these two authors collaboration is primarily characterized by the following: intensity of the relationships between learners, dynamic communicational flow, reduction of duplication and overlap, lower level of risk and richer reward satisfaction once the students achieve their learning goal. Furthermore, these characteristics of collaboration lead to increased efficiency and effectiveness of the entire learning process. More specifically, the authors argue that learners, i.e. collaborators "realize that to achieve outcomes they have to agree to radically alter the way that they think, behave and operate. Collaboration is not about making adjustments at the periphery; it is about systems change" (Keas and Mandell, 2009, p.2).

In the same vain, Gilbert and Driscoll, (2002) consider that knowledge-building communities are entirely based on the idea that knowledge is constructed as a collective goal through the process of collaboration. Act of collaboration is seen as a critical element of knowledge-building regardless of the area of study, level of students' proficiency or learning environment. Gilbert and Driscoll note that the main focus of learners' activities is on "developing the collective knowledge base of the community and improving the problem-solving expertise of the learners" (Gilbert & Driscoll, 2002, p. 59-60). It is also worth mentioning Bowen's et. al.(1992) standpoint regarding collaboration and knowledge-building in the higher education settings. These authors emphasize intellectual collaboration as one of four crucial knowledge building community traits. Thus, by embracing collaborative approach learning, communities become more capable of solving complex problems than individual learner or group of learners.

Alongside with the instructional value concerning collaboration in the classroom, it would be remiss not to note the importance of developing students' critical thinking skills. There have been numerous attempts to define this type of thinking. For example, Gilbert considers that critical thinking "is reflective and reasonable thinking that is focused on deciding what to believe or do" (Ennis, 1985, p, 45). This relatively broad definition emphasizes the importance of using reasoning (evaluation / assessment of thinking) and reflective approach (thinking about thinking) as mental activities to create a meaningful and long-lasting learning experience. Undoubtedly, critical thinking relies on using an ample of evidence to support or build up arguments which provide solid ground for learners' decision.

Sanders and Wiseman (1994) conducted an interesting empirical study aimed to explore the relationship between argumentation and critical thinking. This study demonstrates that argumentation training boosts learners' skills in the domain of critical thinking. According to these authors the obtained results "reflect the enhancement of critical thinking by (a) improving students' abilities to discern weak arguments, (b) improving self-reported arguing effectiveness, and (c) decreasing reported verbal aggressiveness" (Sanders & Wiseman, 1994, p. 34).

Researchers and practitioners in the field of education are facing an additional challenge of linking the appropriate teaching methods to the process of collaboration and critical thinking. Broadly, dialog, as a teaching method, may be defined as interaction through communication between instructors and learners and learners themselves. A more specific definition of the instructional dialog can be found in Moore's (1993) work. According to this author dialog is developed by students and instructor during the sequence of interaction while one provides

instruction and the other reacts. It refers to the extent to which learner and online teacher are willing and capable to respond to each other. The author emphasizes that this term is used to describe "an interaction or series of interactions having positive qualities that other interaction may not have… The direction of the dialogue in an educational relationship is towards the improved understanding of students" (Moore, 1993, p. 24).

Using dialog as a teaching method has many benefits on learning (Mercer & Littleton, 2007). This is especially evident in a collaborative critical thinking session. Engaging into argumentation and dialogs helps students to understand their own perspectives and the perspective of the other participants (Wegerif, 2006). Understanding one's own perspective and the perspective of other people can support the development of communications skills to build social relationships, which is critical aspects for establishing a collaborative learning environment (Greene & Burleson, 2003; Ravenscroft, Sagar, et al., 2007; Smith, 2010; Turnbull & Carpendale, 2001). Another important skill that dialogues may improve is the flexibility of changing thinking style and adopting others' mental models (Ravenscroft, Wegerif, & Hartley, 2007).

DIALOG GAMES

Dialog games may be classified as a group of distance education tools which are designed for argumentation support by enabling the construction of structured patterns (e.g. helping, information-seeking, information probing and instructing) of communication in an ongoing dialog between online learners (Mann, 1988; Mcalister, Ravenscroft, & Scanlon, 2004; Ravenscroft & Pilkington, 2000). Dialog games have a tremendous instructional potential. This online instructional tool can be implemented into e-learning scenarios to help students to engage more vigorously into threaded discussions and/or argumentations for supporting critical thinking. The particular advantage of the DiaCog game is capability of structuring the instructional dialog which provides a stimulating online environment for participants to structure their thinking, observe the ongoing path of the interaction and shape their thinking style in a particular online dialog (McBurney & Parsons, 2001; Ravenscroft & Matheson, 2002; Ravenscroft, Wegerif, et al., 2007). A typical dialog game sets clear goals for argumentation moves (e.g. propose, inform, question and support), specifies certain roles for each of the participants (Johnson, McBurney, & Parsons, 2005; Kimball & Palmer, 1978). These attributes of dialog games form the ways of structuring the dialogs.

The large body of literature indicates that learning scenarios which incorporate dialog games as part of educational process improve or change students' understanding of the topics (Ravenscroft, 2000; Ravenscroft & Matheson, 2002) and advance argumentation and students' reasoning skills (McAlister, Ravenscroft, & Scanlon, 2004a).

DIALOGUE GAMES VS CHAT AND DISCUSSION FORUM

Dialogue games are mainly designed to support the effective use of dialog based on its own unique design (goals, moves, roles, rules etc.). Ravenscroft (2007) advocates that the dialog games are more powerful instructional tool than the chat or synchronous discussion boards. The author primarily emphasizes that dialog games provide a specifically designed platform for a high quality and engaging critical dialog that results in a positive change in cognitive reasoning.

Undoubtedly, the learning ecosystem and instructional nature of traditional tools such as chat and threaded discussion are different than dialogue games. For example, some other recent

studies argue that these environments are allowing domination of some participants, superficial levels of discussion, misunderstandings and poor reasoning based on change of opinions rather than critical thinking and deep reasoning (Ravenscroft, McAlister, & Sagar, 2010). Moreover, these environments do not provide full support to the instructional dialog. (Ravenscroft & McAlister, 2006a).

PLAYING DIALOGUE GAMES

To turn dialog games into a successful online instructional tool, it is required in the phase of argumentation and/or dialog to pre-define a few elements such as a) goals to express the meaning that the participants wish to convey, b) roles for the participants, c) structure specific moves, and d) rules in order to activate intended goals. Every dialog game starts with a topic, which is a seed move enabling the participants to react on it. This initial seed topic defines the overall goal of whole argumentation. In a learning scenario that engages collaborative critical thinking, these topics should be carefully selected by the author in order to create an atmosphere to initiate argumentation for the participants.

For e-learning implementations, tutors may provide a list of different topics for different dialog game sessions. Learners may enroll in the dialog game activity by clicking on the links provided for different topics. These different dialog game activities which are set by the tutor may be seen by participant learners at a time or the list of links may be updated according to the progress of ongoing lesson.

For seeding the dialog games, usually tutors use questions to be discussed on as a starting point. The participants are required to select the seed to start the dialogue. The ultimate goal of the participants would be to show and/or develop their understanding of the topic and practice their skills of argumentation in order to carry on with the dialogue. The participants may take different roles through the dialogue games, such as being a discussant, facilitator or etc.

Dialog games may be carried in a turn-taking approach. Ravenscroft (Ravenscroft et al., 2010) suggests that the turn-taking approach would ensure that dialogues remain coherent, logically and coherently displayed and appear more linear. Moreover, he adds that the approach also lets the participants not to rush the replies and observe and 'listen' to the developing dialogue. According to Ravenscroft and collaborators (Ravenscroft, 2000, 2007; Ravenscroft & McAlister, 2006b; Ravenscroft, Sagar, et al., 2007; Ravenscroft, Wegerif, et al., 2007), the participant who has the turn selects one of the moves form a list or a menu of predefined move categories (e.g. "Inform", "Question" "Challenge", "Reason", "Agree", "Maintain") and then selects specific locution openers to begin to build their expressions. Well selected locution openers help participants to focus on particular aspects of the dialog as research studies indicated (Robertson, Good, Pain, & others, 1998).

The openers may encourage participants to keep structuring their arguments and consequently produce more solid responses. The game openers also require participants to think about the pattern and structure of the ongoing dialog (Ravenscroft & McAlister, 2006b). These openers could serve as dialog strategies where participants need to be careful while performing their moves. These strategies may include facilitating questioning and qualifying propositions, introducing evidence and prompting rebuttals (Ravenscroft, 2007).

VISUALIZING ONLINE DIALOG GAME INTERACTIONS WITH DIACOG

Cognitive mapping technique may represent the mind set and thinking of the participants in a dialog and it may show the relationships – interactions between participants. Cognitive maps are a more direct way of visualizing participants' thoughts because they capture the thinking process of other participants rather than the map creator's perceptions only (Eden & Ackermann, 2004). Cognitive maps may be considered as one of the most intuitive ways for visualization dialogs because they are easy to manage, with imposing little or no cognitive load (Shum, Li, Domingue, & Motta, 2003).

It is possible to apply cognitive mapping technique for dialog games to visualize the thoughts and interactions of participants in a dialog. Applying the cognitive map technique, the DiaCog, which is an experimental prototype research tool, designed for visualizing dialog interactions within an online dialog game, supports students to be more effective in the learning process. The DiaCog dynamically creates interactive cognitive maps of the dialog game interactions throughout the dialog. The DiaCog application uses communication protocols that are carried over XML and the graphical user interface is created by Live Code to be able to run it in cross platforms including Windows, MAC, Linux, iOS and Android environments.

PLAYING ONLINE DIALOG GAME WITH DIACOG

Table No.1 shows a part of a hypothetical dialog constructed using entries from different postings on blogs and internet pages ("Hyphotetical Dialog Construction," n.d.).

Table No. 1 - An Example Dialog

START: Copyright laws and policy could be better aligned with the interests of both consumers and copyright holders.

- Player A: **I agree**, although the Copyright Act attempts to balance culture and commerce through exclusive incentive models and fair use defenses, the law just doesn't seem to be keeping up with the way end users, developers, and content creators operate in the digital sphere **[Round 1], [Agree]**.
    - Player D: **For instance**, current copyright laws are inadequate for the digital age anyway, some legal experts says "Most of it was written more than a quarter century ago," **[Round 1], [Support]**.
    - Player A: **For example,** we see it all the time on YouTube: people communicating through shared content without permissions. **[Round 3], [Agree]**.
    - Player C: **I think so,** with the influx of innovative technologies comes new opportunities for artists and creators to earn a living, but it is often on the fringes of traditional copyright laws.
- Player B: **Is it the case that**, the Copyright Act protects "original expression," but what is considered "original"? **[Round 1], [Question]**.
    - Player C: **I read that**, a work can only be original if it is the result of independent creative effort. It will not be original if it has been copied from something that already exists. If it is similar to something that already

exists but there has been no copying from the existing work either directly or indirectly, then it may be original. **[Round 1], [Inform]**.

- Player B: **I am not sure about that**, copyright protection should not depend on the artistic quality or merit of a work **[Round 2], [Challenge]**.
- Player C: **I read that**, the term "original" also involves a test of substantiality - literary, dramatic, musical and artistic works will not be original if there has not been sufficient skill and labor expended in their creation. But, sometimes significant investment of resources without significant intellectual input can still count as sufficient skill and labor. **[Round 2], [Support]**.

- Player A: **For example**, there is much case law indicating, for example, that names and titles do not have sufficient substantiality to be original and that, where an existing work is widely known, it will be difficult to convince a court that there has been no copying if your work is very similar or identical. **[Round 3], [Inform]**.
  - Player D: **I am agree**, if your work is very similar or identical to something it is not original. **[Round 3], [Agree]**.
    - Player B: **I am agreeing on that**. **[Round 3], [Agree]**.

Player D: **I think.** the purpose and character of the use of the works are important. If the new work is transformative the law should be evaluate that aspect. **[Round 2], [Propose]**.

This small dialog in table No. 1 shows an example of interaction between players in a typical dialogue game. In this table, the rounds are indicated as round numbers in the first bracket and the dialog moves are coded in the second bracket at the end of players' entries.

As in the example in Table No. 1, dialog may go in a way that the players may reply to previous entries so that there is no linear order in the dialog. Therefore the ongoing dialog cannot be read as reading a page of a book in a top to down direction because the events are non-linear.

In order to continue with the dialog games, participants should have selected some pre-defined moves. Table No. 2 shows the list of available dialog moves in the game.

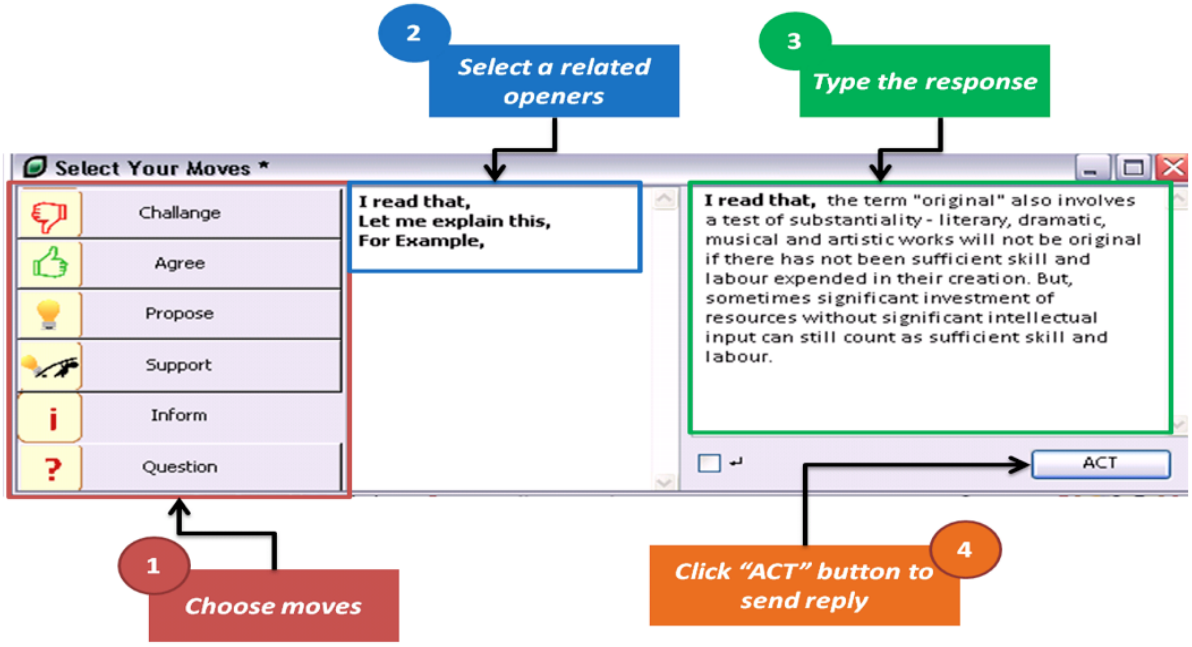
Table No. 2 - Available Moves in the Dialog Game

Icon	Meaning of the move	Icon	Meaning of the move
	Challenge: Ask for justification or weaken a claim or attack.		Support: Provide support to previous moves.
	Agree: Accept the move.		Inform: Give information or answer a question.
	Propose: Generate a proposal, idea or present a solution.		Question: Seek information.

In order to make a move, a player should respond to an idea of the others or the "START" idea by clicking reply button next to related idea or the START button. After a player clicks a reply button a pop up screen for move selection is displayed to let him/her enter the response as shown in

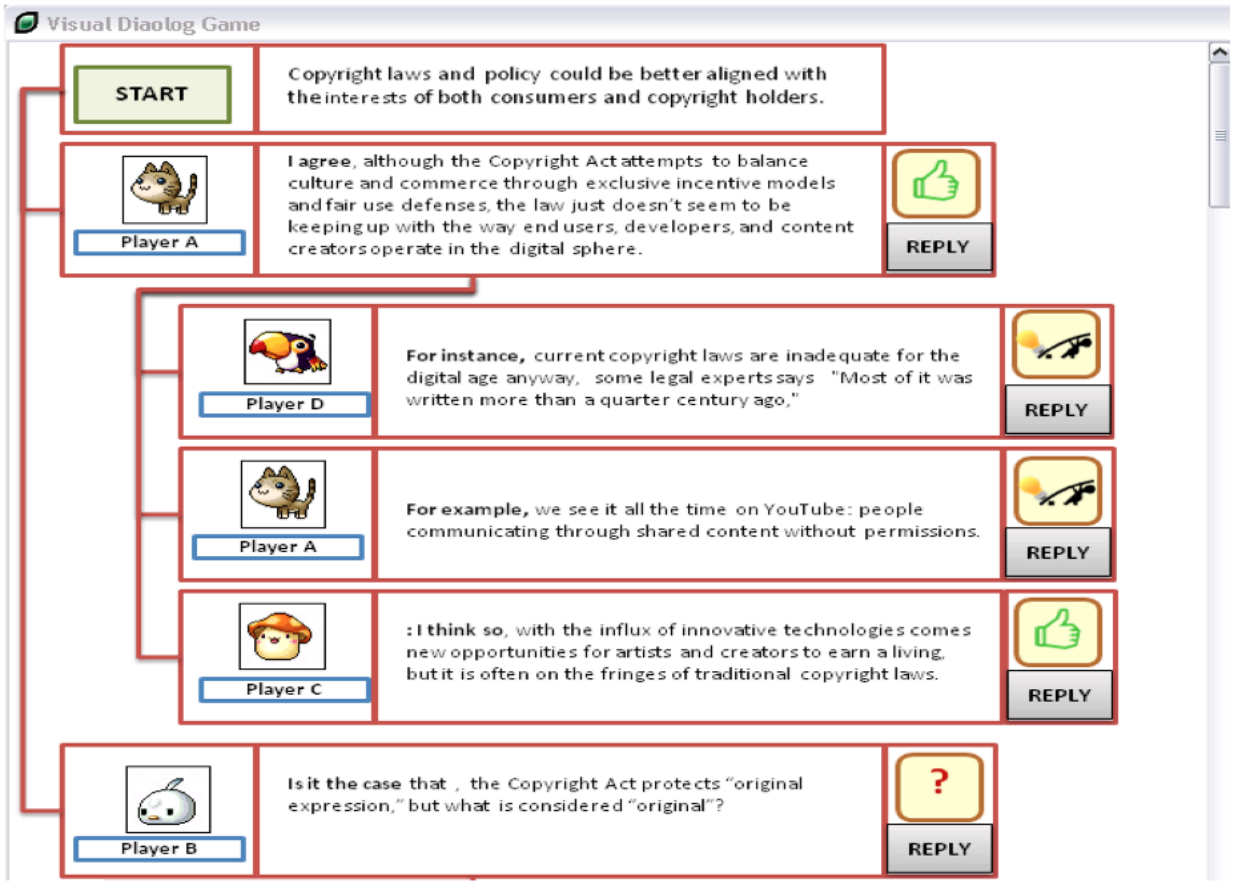
Figure No.1. In that screen participants are required to choose their moves from the list and related openers from a list, and to type the text of their response. After finishing building the expressions, participants simply click the "ACT" button to send their replies.

Figure No.1 - Move Selection Screen



After the reply to a certain entry is provided, the DiaCog automatically draws relationship connectors, moves icons and a reply button next to the related player's entry, as in **Error! Reference source not found.**. The participants are also represented with avatars that they select before they start the game.

Figure No. 2 - Graphical Representation of Dialog Game



Each player move is represented as text format and marked up with an appropriate icon. To respond to the other participants' moves, a player needs to click the reply button and make a move.

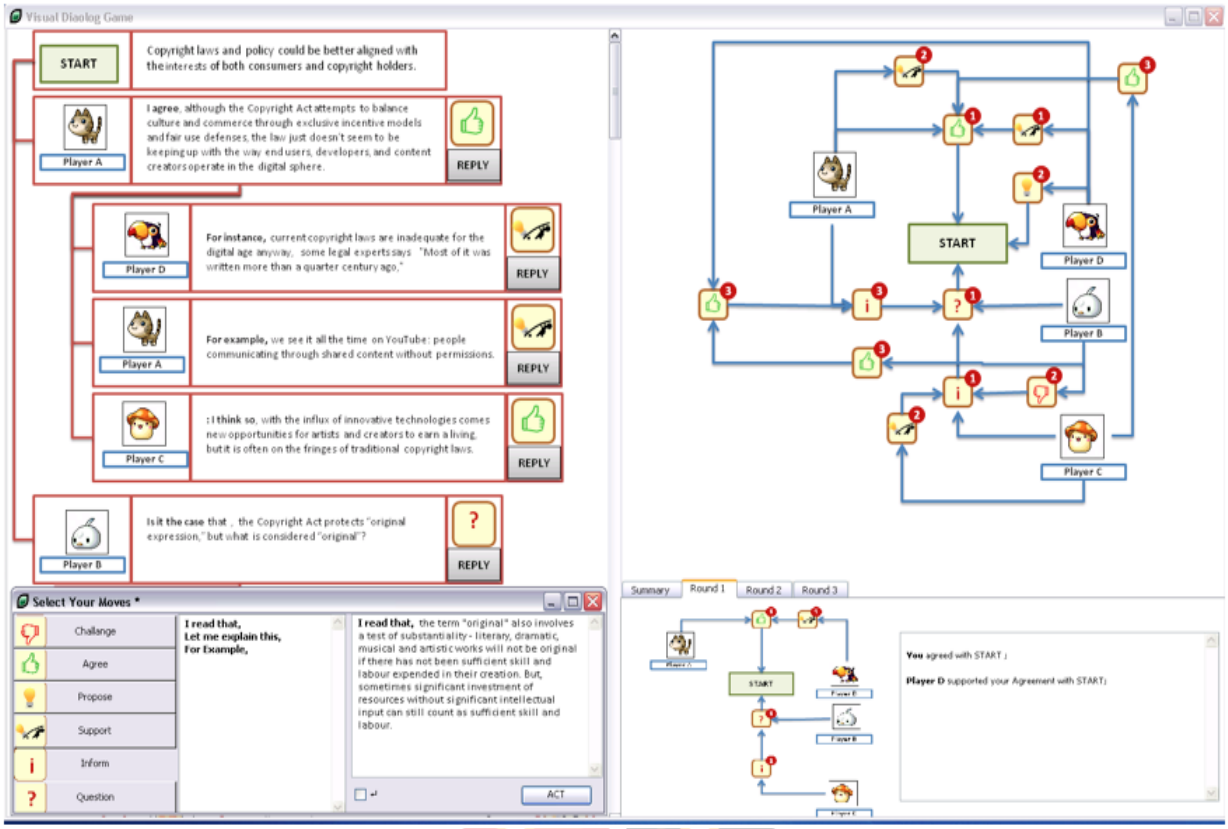
CONSTRUCTION OF COGNITIVE MAPS

The dialog interaction and moves could be visualized into a cognitive map, which would help students to note and read the non-linear interactions more easily. Figure No. 3 demonstrates a cognitive map of a section of the dialog in Table No. 1. From this map players (or an observer) may easily track the dialog moves.

The dialog moves are indicated as a button and the rounds are labeled and numbered (red dots). The dialog interaction and relationships can be tracked by following the connector lines. For example, from the map in Figure No. 3, it can be read that in the first Round, Player A agreed with the START move (starting topic seed). Then, in the second round Player A supported his agreement move and in the last round, he informed the question of "Player B" which was uttered in the first round of the game. Moreover the interaction with other players can be read from the same cognitive map in Figure No 3. For example, Player A's second move, was to "support" his first move (agreement). Player A's second move was also agreed by Player

C in Round 3. Player 1's first move (agreement with START) was also supported by Player D in first round.

Figure No. 3 - Main Screen of the DiaCog

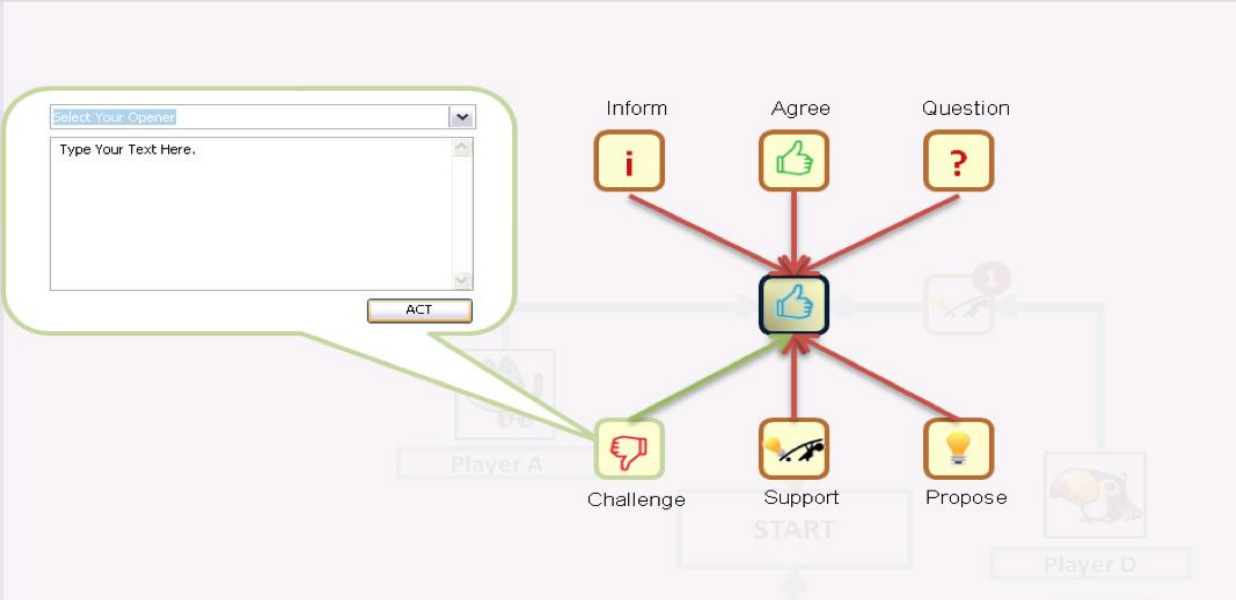


The proposed system constructs maps on the fly automatically as the players engage the moves. As the players respond to an idea the system creates the related button and the links. For example, when Player D responds to Player B, the system creates a button with a designated movement icon (e.g. Challenge, Agree and Question) and draws a connection line from Player D to the currently created button and from the currently created button to the action of Player B to which Player D is responding.

In each round the system creates two maps - a summary map for all the actions performed in all rounds, and a separate map for the current round. These maps are located on the tabs menu which is at the lower right end of the main screen, as shown in Figure No. 3.

The moves are also linked by using interactive maps, as it is represented in Figure No. 4. These interactive concept-maps are flexible, manageable and with user-friendly interface.

Figure No. 4 - Dialog Move Interaction on Cognitive Maps



Players can respond directly to previous moves by clicking the moves of other participates which are represented by a move button on the maps or the START button which is located in center of the maps. After clicking a button representing the others' moves, a list of possible moves and a text bubble; which shows the text for the move and is connected to that move; pop up. When the player selects a move from the list, a bubble text with an opener selection menu pops up so that he or she can respond as it is shown in Figure 4..

SUMMARY

This paper proposes and describes the design of the DiaCog prototype tool for visualizing dialog games by using dynamic cognitive maps. The DiaCog tool design might be applicable to dialogs at discussion boards in online learning applications. The DiaCog is still an experimental learning tool with permanent updates and improvements. This prototype has not yet been evaluated within real learning environment yet. Even though the DiaCog tool is in the initial phase of testing, a large body of literature suggests that the DiaCog would be applicable to promoting collaborative knowledge building and critical thinking skills. As a future study, this system may be implemented into an online learning system and the user interaction and impact of the tool on learning may be investigated with user studies. Moreover, the DiaCag tool may be integrated into an artificial intelligence system to coordinate the interaction and argumentation in a dialog game.

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