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Collaborative E-Learning with Multiple Imaginary Co-Learner: Design, Issues and Implementation

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***Abstract*—**Collaborative problem solving in e-learning can take in the form of discussion among learner, creating a highly social learning environment and characterized by participation and interactivity. This paper, designed a collaborative learning environment where agent act as co-learner, can play different roles during interaction. Since different roles have been assigned to the agent, learner will assume that multiple co-learner exists to help and guide him all throughout the collaborative problem solving process, but in fact, alone during the learning process. Specifically, it answers the questions what roles of the agent should be incorporated to contribute better learning outcomes, how agent will facilitate the communication process to provide social learning and interactivity and what are the specific instructional strategies that facilitate learner participation, increased skill acquisition and develop critical thinking.

***Keywords*—**Collaborative e-learning, collaborative problem solving,, imaginary co-learner, social learning.

I. Introduction

COLLABORATIVE problem solving in e-learning has been addressed by several researches in the field of mathematics and computer science by allowing learner to discuss problem, share their cognitive resources and working together to produce a unified outcome. They are supposed to establish joint goals, make decision and construct and modify solutions if necessary, and evaluating outcomes through dialogue and actions [10]. The use of social networking technology has been used to achieve collaboration that allows massive learners to participate in the blog [2], [8] and peer to peer and active learning [6]. Another method that has been used in collaboration is connectivism theory that uses technology, social networks and group task [11]. Instructional strategist realized the potential use of agent to perform collaboration and help the learner to achieve the learning goal [1], [12].

However this agent has been designed to perform a single specific task to help the learner in achieving the goal of the learning process. In this paper we will investigate how to incorporate different roles to an agent, and act as a co-learner in collaborative problem solving. Since different roles have been assigned to the agent, learner will assume that multiple co-learner exists to help and guide him in the collaborative learning process. Although the design is to deceive the learner, it is believed that it will help him to develop critical thinking and increased skill acquisition.

A key to collaborative learning is to address the issue of communication and how social interaction will occur and what roles of agent should be included to facilitate problem solving? For this, an agent can achieve an almost natural human-computer interaction and are life-like computer characters that can interact with learners. They do so by picking up phrases from database, according to predefined set of rules so as to achieve effective communication [3]. These agents respond to user actions and have enough understanding of the learning context and subject matter that they are able to perform useful roles in learning scenarios. For example an agent can act as learning companions [4], collaborator and competitor [7], peer tutor [13]. Such discussion focuses on how agents fulfill their educational duties. Moreover, agents are designed to help transmit knowledge or skill to student by an interactive process and usually focused on how to make socially aware learning environment that interject social remarks and comments [9]); but must be carefully crafted in a way that it will not hurt or hinder the learning process but to motivate the learner [14]. Imaginary co-learner allows student to collaborate and share ideas to make the learning process interesting [5].

Using imaginary co-learner the system monitors real learners' progress in learning. In fact, imaginary co-learner can be simultaneously an expert and a co-learner, scaffolding and guiding the humans learning in subtle ways. The agent will be able to adjust flexibly to the cognitive level and schemata of the learner he interacts with. He will take in consideration the knowledge and cognitive level capabilities of the learner and adjust so as to become a co-learner with about the same capabilities so as to be able to converse and cooperate with the learner. During the cooperation the agent will provide information and help in the form of suggestions, like hints/motives that will activate the learner's thought so as to help its further development. The agent will help the learner develop his thought so as to advance "cooperatively" – but in fact alone – to the solution of the problem. Thus the learner will feel that he has a synchronous co-learner, while, in reality, he will work in an asynchronous learning environment. Thus a natural human-computer interaction is achieved, while learner has all the advantages and benefits of cooperative learning, only with a imaginary co-learner.

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The paper is organized by discussing the system definition of collaborative problem solving, roles of different agents, how to achieve collaboration and social communication, and discussion of issues and design in the implementation of the system and a brief conclusion and recommendation of the study.

II. Background and System Definition

A common feature of creative problem solving is to place students in the midst of a realistic, ill-define, complex, and meaningful problem with no obvious or correct solution. Students work in teams, collaborate and settle the best possible solution on time. In finding the solution, students will undergo several stages such as formulating the problem, recognizing facts to solve the problem, establishing the goals, listing possible solutions, evaluating, testing and finally presenting the approved solution among the group. Although, this can be achieved by the presence of physical learner collaborating one another in an asynchronous way, this can also be achieved through the use of agents.

In this paper, collaboration is achieved through assigning different roles to an agent to solve the problems but first, it should collect the learner profile to be used for the selection of the right agent. The issue is focused in the number of answers that will be integrated in the agent's database, which, should be appropriately modified so as to fit to the relevant cognitive level of the learner and to his character. The choice of the appropriate agent will be according to the answers each learner will provide in the beginning of the course so as to form his profile. The questions the learner will answer, will concern his general knowledge, special knowledge, personal data, elements of his character and some psychometric test questions. Thus the learner will have a personalized cooperative co-learner intelligent agent. The learner will not be aware that his co-learner is not a human person, but still he will have the illusion that it is real, since the agent will be able to cooperate with him for the solution of a problem in synchronous learning situation. The advantage is that the learner can cooperate with the agent whenever he, himself, can, a fact that releases him from the time limitation. Upon establishing the profile of the students, roles in achieving collaboration can be defined.

III. Role System Design

From a social perspective, a role can define the relationship between members of a group who are collaborating to solve the problem [8]. The general function of the role is to manage expectations among learner. In the case of software applications, agents' roles can always be implemented using user access control to specify permissions among users, so as to agents; to facilitate proper communication and activate their respective played roles in the collaboration process based on predefined rules stored in the database.

In the system, five roles has been identified, Tutor, Brainstormer, Narrator, Evaluator and Moderator as shown in Fig. 1. It also shows the user profile collected in the beginning of the course. Different student have different level as result of collecting prior data. This user profile will be used to create a personalized cooperative co-learner agent.

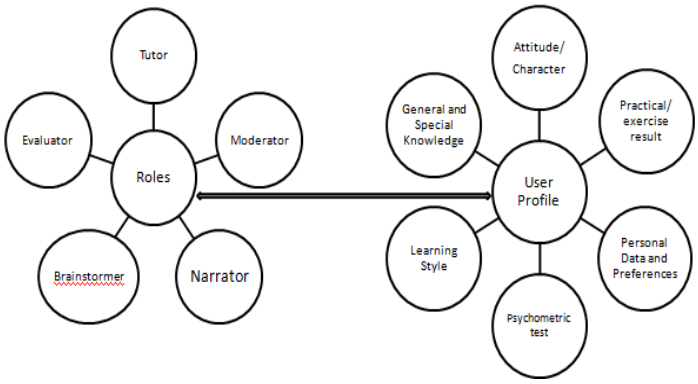

Fig. 1 User Profile and Roles Framework

In the roles policy, the Tutor is assigned by default to the learner while other roles can be performed at any given time depending on the circumstances. During the collaboration, agent can switch roles depending on the predetermined events stored in the databases [3]. All of these roles are meant to encourage participation and can access certain task.

Tutor role is responsible in making introduction about the lectures, show problem and encourage the learner to follow the instructions in solving problems usually in the form of tutorials. It can ask conceptual questions to determine understanding, discuss additional concepts and provide explanation facilities if needed through social interjections and post problems to be solved. The knowledge and theories to be taught are stored and provides mechanism to efficiently present the subject matter to the students.

Brainstormer role is intended to allow users to freely suggest ideas without self censoring or criticism. In the system, this is made possible by activating several ideas stored in the database related to the problem and presents it to the user as if there are many users trying to exchange ideas and opinions in the process. The Evaluator stored all the suggestions and alternatives by building a tree, in which individual nodes are states that represent solutions or partial solutions. In the event that no solution found during testing,

the Narrator role can come and use its knowledge and perform backtracking mechanism until such time that it can established a solution path of the problem. On the other hand, the Moderator role is intended to keep the communication process and exchange of ideas going but the fact is; it just used to deceive collaboration process by connecting social interjections stored in the database and pretend that several co-learner performing different task are collaborating in solving the problem.

IV. Collaborative Problem-Solving Issues

In order to support problem-solving efforts of a learner using cooperative procedures, a software system has to provide:

1. A step by step method in solving procedure should be split into discrete easy to follow steps. The Tutor role provides a complete list of steps that is available to the learner. The learners will be called to apply some of these steps with the collaboration. Generally, the tutor provides a step-by-step procedure for creating or modifying a collaborative lesson and the learner applies this collaborative lesson to the learner. A connection to one or more learning objects database must be established.

2. Turn-taking conventions govern dialogue to ensure that either the learner or the virtual co-learner communicates at a time until the completion of a turn. This is done by Moderator by keeping the communication going during the collaborative problem solving while Brainstormer keeps on suggestions and giving opinions in the process.

3. As the problem-solving procedure depends on a sequence of learner's responses, the procedure is synthesized dynamically. In order to have such on real time synthesis of the proposed solution of the problem, the possible scenario has been designed on a tree having as many levels as many steps the proposed solution has (Evaluator). Therefore, the procedure follows a path according to the learner's responses at each step. Learners get an impression of collaborating with a co-learner.

4. In the event that the partial solution failed, the Narrator will match each partial solution to correct solution stored in the database and re-start the process. Performing backtracking is necessary to keep the group working and not to waste the collaborative effort done by the group.

5. Achieving goal or a final solution should be submitted as a product of the collaborative effort. The Evaluator should compare the solution stored in the database and inform the Tutor virtually that the solution matches with the database.

Fig. 2 shows how different roles can be performed by switching from one role to the other. By default, the Tutor role will be depicted providing introductory lesson and tutorials including step by step solution to the problem at hand. The strategy here is to deceive the learner that different co-learner is helping him but in reality only one agent is performing the entire task. All roles will be activated by predetermined rules that can be fired at random order depending on the perceived communication of the learner to the current agent role. For example, initially the Tutor will initiate the collaborative problem solving by posting a problem and help the learner to identify the problem, asked the given data and other.

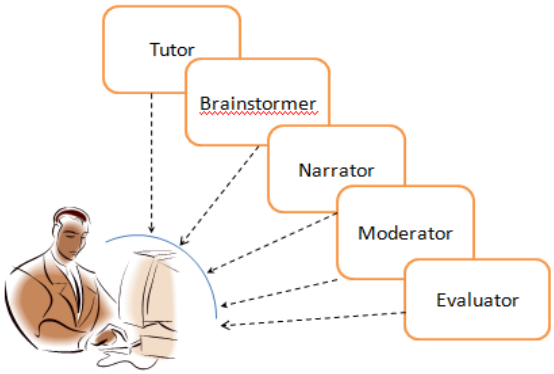

Fig. 2 Agent Roles Architecture

Brainstormer on the other hand injects one suggestion/opinion as a front that a co-learner posted its idea but in reality in is just one of the data stored in the database. The Narrator will deceive the learner that different co-learner is helping him in solving the problem by keeping the communication continue by switching from one role to another. The Moderator is busy studying the tree generated by the Evaluator as partial solution to the problem, if in case a solution is not found, a backtracking mechanism will be activated. The next section will discuss in detail how different roles are achieved in collaboration.

V. Achieving Collaboration

Applying the different roles discussed in the previous section, Fig. 3 (a) illustrates the sequence that makes possible the collaboration process. The Tutor load the problem to be solved collaboratively and the learner will try to solve on his own, in this scenario the Tutor role is observing the learner behaviour by recording time, solution and interject social remarks if necessary. In the event that Tutor observed difficulty, collaboration will occur. Tutor will shift its role to Moderator to record the sequence of events and determine what roles should be activated based on social remarks recorded in the database. The Moderator will then shift its role to Brainstormer allowing to load an idea or suggestions from an imaginary co-learner, the Learner will then have the option to accept or not the suggestions or the ideas of the others. If it accepts, the collaboration will continue, requiring the Learner to submit his own solution based on the suggestions of the others. The Tutor at this time will keep communicating to the Learner to help him achieve the goal. The submitted solution will then be evaluated by the Evaluator if the partial solution is relevant or irrelevant. The Evaluator will tag "relevant" if the answer is potentially acceptable in solution space, if not, "irrelevant" tag will be made. The "relevant" tag will be added to the solution space which is usually added as a node in a tree by the Narrator.

The Evaluator will only validate the answer based on the stored solution space in the database. All solution will be

compared in the solution space, relevant tag will be added to the tree until goal has been achieved. However, in the course that solution cannot be found, Fig. 3 (b) sequence of events will be executed.

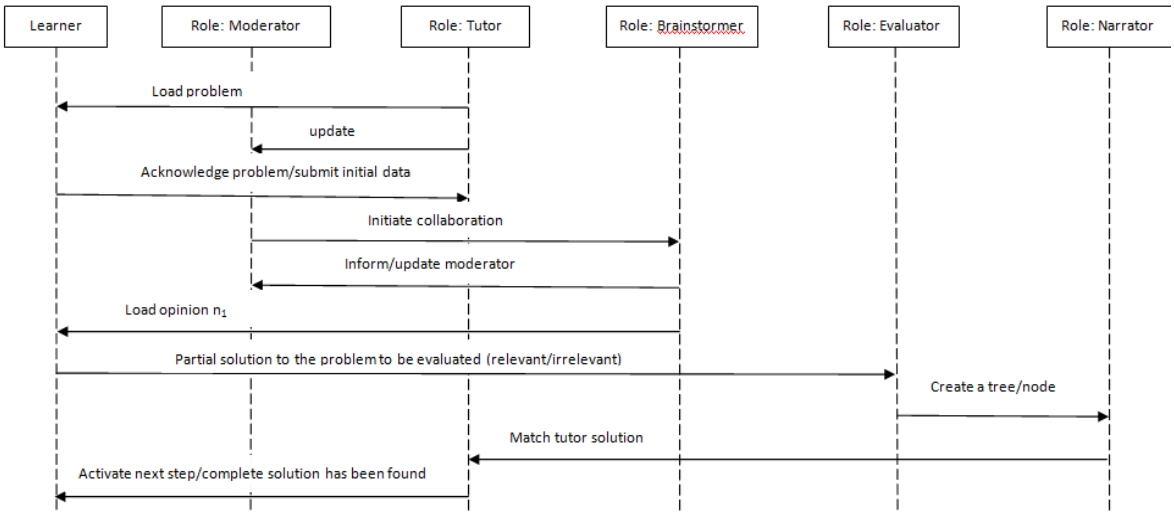

Fig. 3 (a) Sequence Diagram for achieving collaboration in problem solving assuming that solution path is establish

Based on the reported sequence of solution submitted by the Learner, a solution is not found. In this event, the Tutor will inform the Learner that the goal have not been achieved and shifted its role to Moderator to activate the role of Brainstormer.

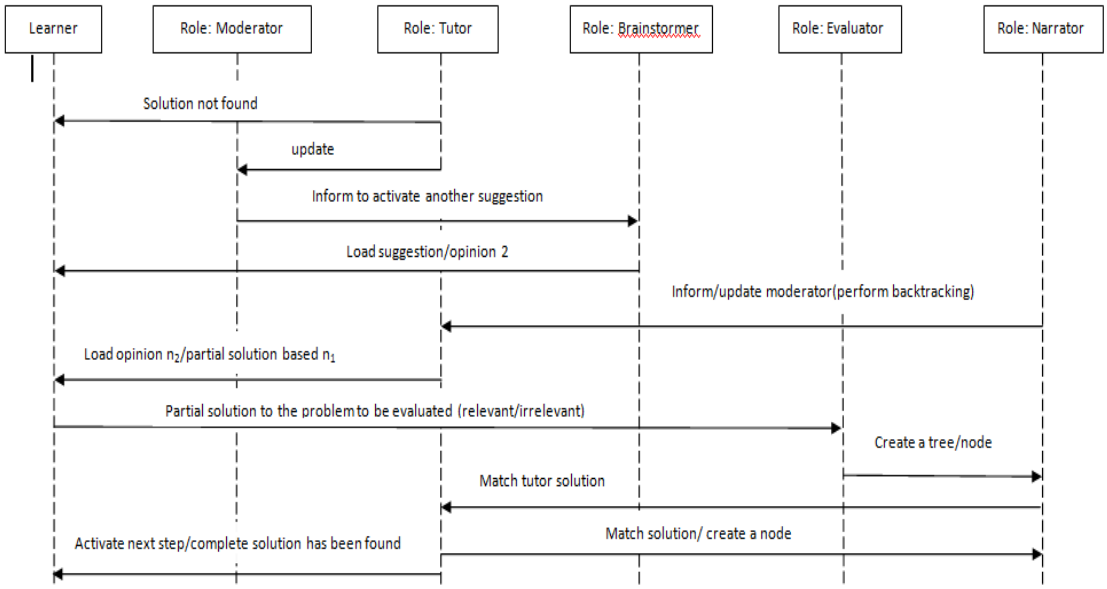

Fig. 3 (b) Sequence Diagram in achieving collaboration in the event that solution is not found

VI. Conclusion

In this paper, we achieved collaboration in problem solving through assigning different roles to an agent and deceived the learner that several co-learners are helping him in the learning process but in reality he is working on his own. Five roles have been identified switching from one to the other. Also, steps in collaboration and socialization have been achieved as shown in the architecture and framework.

As further work, we plan to implement and test fully into working e-learning system and to enrich the agent through mining the data supplied by the learner and continuously building a learner profile. It is also very interesting to continue and add more collaborative features and perform individual assessment to determine if there is an improvement of critical thinking and acquisition of knowledge of learner.

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