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Development and use of computer aided tools to enhance team dynamics with role play simulations

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Department:

DEVELOPMENT AND USE OF COMPUTER AIDED TOOLS TO ENHANCE TEAM DYNAMICS WITH ROLE PLAY SIMULATIONS

by

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ABSTRACT

This thesis proposes a methodology for the development and use of computer based tools to enhance student team dynamics. Working effectively in groups cannot be taught in class room environment. Students often encounter conflicts during team meetings. Although some conflicts are resolved by the efforts of team members, an unbiased facilitator who is not a member of the team is often needed to help. This work proposes a tool that uses role play simulations to engage students in real-life scenarios so that they gain a practical, as well as a theoretical, understanding of how to work effectively as a team. The students play roles in the simulations to learn about team dynamics. To assist students in their discussion, a virtual facilitator is incorporated into the system to intervene in student discussions. A set of rules is loaded in the knowledge base of the virtual facilitator, which helps the students understand each others needs and streamlines the communication among them. The rules are based on various theories of conflict management. The system is robust and intelligent enough to monitor conversations among students and to provide unbiased interventions. This computationally intelligent tool is available online for the benefit of students working in conflict management and effective communication all over the world. The use of such computer applications can improve the effectiveness of students working in teams, thus increasing team efficiency at low cost.

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PAPER

1. DEVELOPMENT OF INTELLIGENT WEB-BASED TOOL TO SUPPORT ROLE PLAY SIMULATIONS

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ABSTRACT

Students need practical learning experience with real world complexities to develop skills needed for their future careers. In particular, working effectively in teams cannot be taught theoretically. Simulation games can be used to teach skills related to team dynamics. An interactive and intelligent web-based application is useful to host such role play simulations. The advantages of such a system are that it is available to everyone and can be accessed from anywhere. This paper describes an approach to building one such application. The entire system is designed based on open source software like Java, Apache Tomcat, and MySQL. The system is modeled with two interfaces, one to manage the web interface and the other to manage group conversations in a chatroom. The interactive web interface handles the logistics of the role play simulation, including login validation, briefing about simulation, assigning students to different teams. The intelligent chat interface acts a virtual facilitator to moderate conversations among participants in a role play simulation. The facilitator rules are based on theories of conflict management and effective communication. The system is robust and intelligent

enough to monitor conversations among students and to provide unbiased interventions. Use of such computer applications can improve the attitude of students when working in teams, thus increasing the efficiency of the team at low cost.

1. INTRODUCTION

The traditional approach to education oversimplifies student learning experiences. The limited scope of course content limits student ability to develop skills at managing the complexities of real-life problems. Students who are not exposed to real-world complexities are prone to either overconfidence or boredom. These problems are even more serious when students work in teams. If students are not accustomed to learning-by-doing methodology, they could face trouble in their future careers [1]. Effective team skills may not be taught in a classroom setting or merely by assigning students to teams [2], [3]. An alternative approach to improve the performance of individuals in teams is to use role-play simulation games. Business simulation games are well developed to teach management skills and supplement other instructional activities [4-10].

Diagnostic tools and web-based formative assessments provide opportunities and mechanisms for individuals to assess their own performances in team building activities. According to Bull, Quiqley and Mabott, a wide range of learning settings is now available, encouraging research into pedagogic opportunities they offer. These settings include virtual and real classrooms, with both web and paper-based distance learning [11]. Software plays an important role in developing simulation games because it can provide the complexity and range of experiences needed to acquire targeted skills.

One such software tool is a computationally intelligent virtual facilitator. It contains a subset of the expert knowledge of a skilled facilitator. The virtual facilitator models the behaviors of an expert facilitator to student teams as they are working together [14]. This

facilitator is an interactive chat (Java ™) application that runs on rules and guidelines embedded in the knowledge base of the system.

The use of the World Wide Web for software delivery simplifies the learning process. The flexibility and ease of use of the web browser, graphical user interfaces, and interactive online sessions significantly increase student motivation [12]. Moreover, software fulfills the need of students to play an active role in the learning process [13]. The use of such applications is supplemented with the software that enhances team dynamics. The complete interactive web application is powered by specific role play simulation games.

This paper discusses in detail about the architecture of such systems. The components involved in building an online portal that hosts both virtual facilitator and role play simulations. It also describes about various users and their access to various components of the system.

2. SYSTEM ARCHITECTURE

The system used here to develop an interactive learning process and improve team dynamics runs on Java platform. Java was selected for two reasons: First, Java is an open source language; therefore, it is easy to build and debug the system with help of online forums. Secondly, a role play simulation tool can be made available for almost everyone without the constraints of installation on a particular platform, except for the Java virtual machine. The Java virtual machine is a set of computer software programs and data structures that use a virtual machine model for the execution of other computer programs and scripts [15]. The Java virtual machine is a prerequisite for many operating systems and web applications, thus, it is an installation used by many applications.

A web application can be reached by anyone connected to the internet; therefore, web-based simulations can be widely available. All the simulations developed here sit on a single Apache Tomcat web server. The server used is an Apache Tomcat Server. Apache servers are free and open source servers. The user can connect to this server via a Hyper Text Transfer Protocol (HTTP) link provided by the simulation administrator.

The role play simulation is divided into two segments. The first part addresses the administration of the simulation, and manages team communication using a chat interface. The administration of the simulation is a simple user interface to help the user connect to the simulation game. A group of Java server pages (JSPs) are used for navigation. The availability of access to the website depends on the level of permission assigned by the system manager.

All the data used to verify user credentials or stored for further reference are stored in a MySQL database server mounted in the server machine. This server is open source software. The documents necessary to learn about the role play simulation games and the conversation transcripts are also stored on the server side of the system.

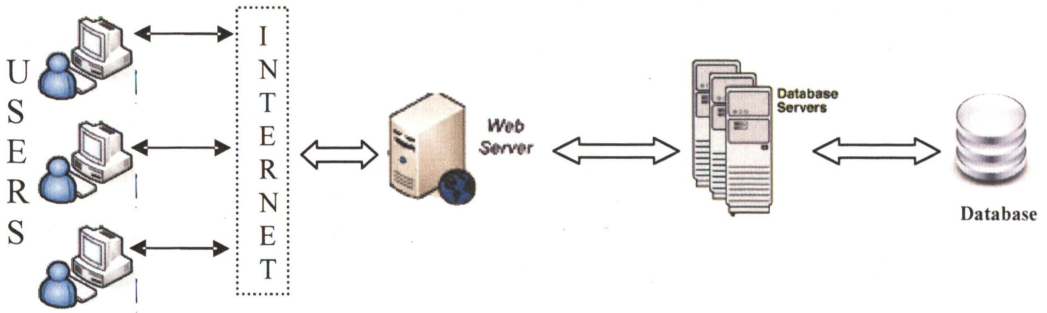

Figure 2.1: Architecture of Logistics of Role Play Simulation

The second segment is the virtual facilitator, a computationally intelligent chat interface that works on a Java applet. An attempt to use the facilitator is called a client-side request. The client-side requests are processed by separate chat servers installed in the main server machine. Various simulation game rooms are available for users to participate in the game. The administrator decides which simulation to join; the game rooms are assigned to a particular simulation based this decision.

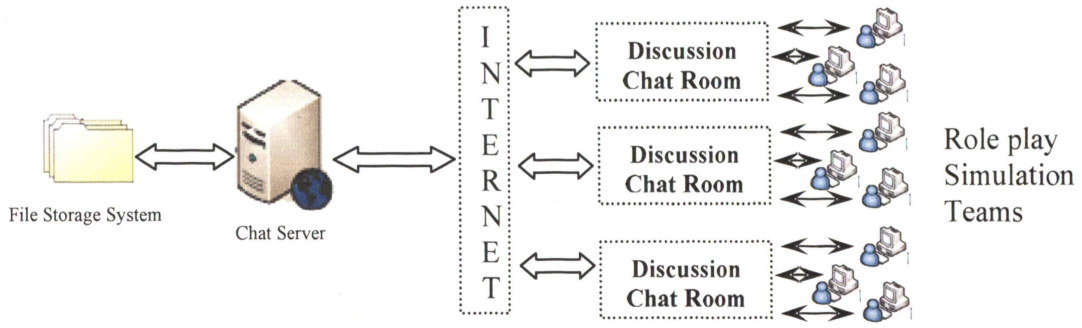

Figure 2.2: Architecture of Computationally Intelligent Chat Interface

Users are categorized into three levels. The system manager is the only user at the top level. This individual can access all the components in the application. The system manager can give administrator privileges to any user. Administrators belong to the middle user level. They can invite users to participate in the role play simulations. Administrator privileges are limited. Users who are invited to participate in role play simulation games are called participants. They belong to the bottom level in the hierarchy.

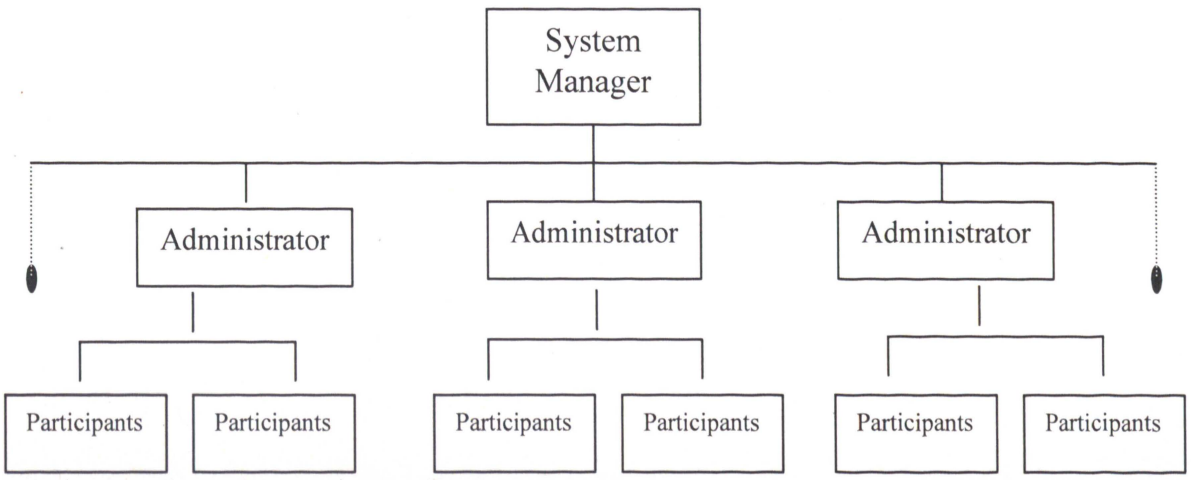

Figure 2.3: User Flow in Role Play Simulation

3. SYSTEM COMPONENTS

Web interface and chat interface are the two segments of this application. This section gives a detailed description of each. Web interface components handle the logistics of the application. Chat interface components provide simulation game room functionality.

3.1. WEB INTERFACE

The web interface administers the application. The various components that are used in building the application are the login component, the assignment component, the mail component, the team selection component, the transcripts component, and the role component.

Login Component: This is the first page a user encounters upon clicking a web link directing them to the system. The user's email address and password are necessary to log into the application. Login credentials will be sent to the user by the administrator. The login can be limited to function only at a particular date and time and to remain valid only for the duration of the simulation. Administrator login credentials remain valid from the day administrator privileges are assigned and end on the date requested to the system manager.

Assignment Component: This component assigns an administrator. This component can be used only by the system manager. The user must request a simulation game and specifies the duration of the game and number of participants involved. With these details, the system manager can give administrator permissions.

Mail Component: This component is available only to administrators. It sends automated email to participants, including the administrator. The message will include details such as login credentials, the date of the simulation game, name of the role play simulation, game room number, etc. This component uses simple mail transfer protocol (SMTP) of the Gmail server (web email powered by Google).

Team Selection Component: This component is accessible only by the administrator. It allows the administrator to assign participants to various teams and to set rules for the virtual facilitator. It also permits the administrator to schedule the date and time of the simulation.

Transcripts Component: This component stores team discussions and facilitator suggestions. It uses the mail component to send transcripts to the participants at administrator's discretion. The chat transcripts are stored based on administrator, game name and, date and time of the simulation. Transcripts can be sent only after completion of a role play simulation.

Role Component: All users invited to participate in the simulation are automatically assigned to a particular role in the simulation. This is a random assignment. The number of roles assigned to the team is depends on the simulation selected by the administrator.

3.2. CHAT INTERFACE

After logging into the system, a user participates in the role play simulation using this interface. The components that constitute the chat interface are the simulation component, the chat connection component, the display component, the analyzer, and the history component. Together, these components act as a virtual facilitator in the simulation game rooms.

Simulation Component: When a user logs into the system, this component loads the assigned simulation game. The virtual facilitator presents the documents that explain the simulation game. This component can also be invoked during team conversations. Administrators do not use this component because they are not assigned roles in the simulation.

Chat Connection Component: The main function of this component is to connect the user to the simulation game rooms. This connection is made according to the team number assigned to the user by the administrator. Each room is called with a port number, which in turn is linked to the team number. Only administrators have the privilege to choose the room they wish to enter in a role play simulation.

Display component: A Java applet is used to display of information to the user. The display has a conversation window, in which user discussions are displayed. It also has a facilitator window that displays computer interventions. An input text box is placed in the window, allowing users to input a conversation.

Analyzer: All input messages are analyzed and processed by this component. The analyzer is the brain of the computationally intelligent virtual facilitator. It incorporates a knowledge base that contains rules about the behavior of the system towards various user messages. The analyzer considers the user statement, and then searches for triggers in the statement that lead to a facilitator intervention. These triggers are based on the rules installed in the system. The functionality of the analyzer is determined by the mode of operation selected by the administrator. Chris Argyris's action science and Marshall B. Rosenberg's nonviolent communication are important rule bases used by the analyzer for two different modes. The analyzer can also provide moderation services for a meeting.

History Component: This component stores all the interventions made by the facilitator and retrieves them for future reference. It also stores vital information in the nonviolent communication mode of the virtual facilitator. In nonviolent communication mode, the user responds to questions about the facts of a situation, feelings, user needs, and then makes a request. This information is stored for use in future facilitator interventions.

4. FLOW DIAGRAMS

Flow diagrams represent the overall role play simulation system flow. The diagrams show the user access at various levels. The descriptions of the diagrams refer to the components described above.

4.1. PARTICIPANT SYSTEM

A role play simulation participant must be invited by the administrator to use the system. A user at this level can access only the login component in the web interface. Based on the administrator settings, the user may be able to access the transcripts component. If the administrator wants to see the discussions that occurred during the simulation, the transcripts component will automatically send the saved transcripts of the discussion to participant's email. In the chat interface, a user can access all the components – simulation, chat connection, display, history and analyzer. After the login validation, a user can join the simulation assigned to him. The participant will be briefed by the simulation guidelines and then diverted to a discussion room based on the team number assigned to him. In the discussion room, the user name is displayed along those of other participants on the team. The discussions entered in the chat are processed by the analyzer, and an appropriate message from the server is displayed. The server messages will be displayed only if a user statement triggers the rules in the analyzer. The triggered statements are stored in the knowledge base for future reference by the analyzer. For example, if a certain trigger is explained by the user in the discussion, then repetition of the trigger in the user statements will not result in any intervention by the analyzer. The storage of user chat information in the knowledge base is handled by the history

component. Users will log out of the simulation after its completion. After logout, a survey will pop up to gather information about the user's response to the experience. Completion of the role play simulation will automatically invalidate the user's login credentials.

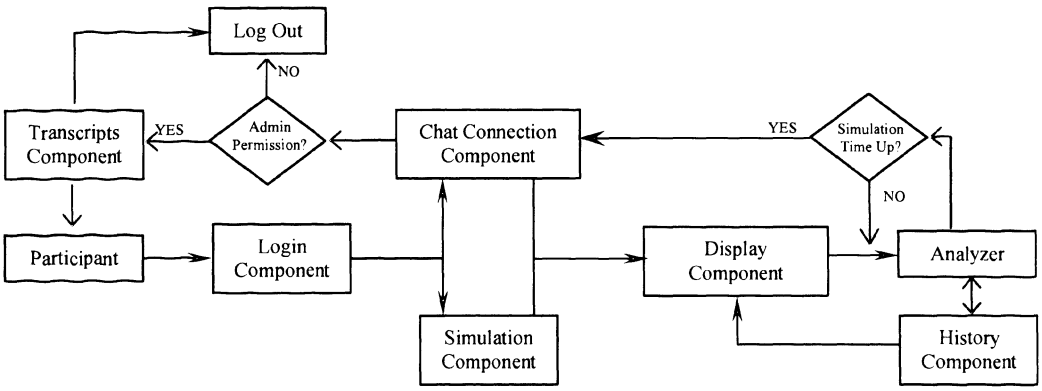

Figure 4.1: Participant Flow Diagram

4.2. ADMINISTRATOR SYSTEM

This section explains the system flow as it applies to the administrator. A user can be an administrator if he specifies to the system manager the name of the simulation, the number of participants, and the end date of the simulation. The administrator uses the following components of the web interface - login, transcripts, team selection, role, and mail. The assignment component is the only one not used by the administrator. Login validation is checked by the login component. The user can login into the system until the

end of the simulation period requested from the system manager. After successful login, a user can choose either to join the simulation or to invite participants. To invite the participants, the administrator must schedule the date and time of the simulation. In the team selection component, administrator must also provide the participant's email address and the name of the simulation. The administrator can also group the participants into various teams. Based on the number of participants in each team, the role component assigns roles to participants. The mail component sends an automated email to each participant, with login credentials, simulation name and time and team number. To join the simulation, an administrator must select the discussion room from the given list of rooms. The process of joining the participants in the chat room is same as that for participants. All components in the chat interface are used. The administrator can also use the transcript component to send transcripts to participant email addresses.

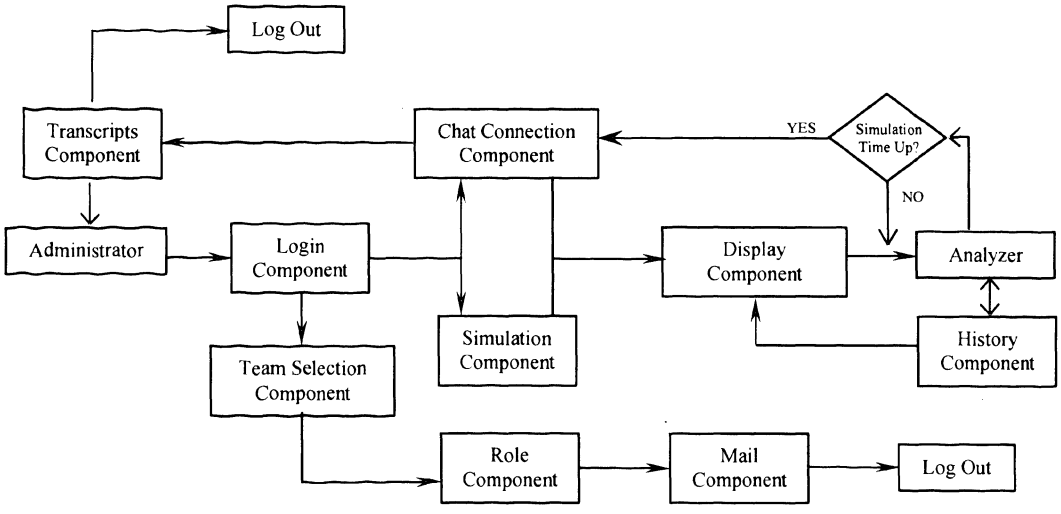

Figure 4.2: Administrator Flow Diagram

4.3. SYSTEM MANAGER SYSTEM

The system manager owns the system. He can access all components in both the web interface and the chat interface. The flow diagrams are similar to those for the administrator system. This system however, has an additional functionality: The system manager can assign a user to be a simulation administrator. After logging into the system, the system manager can access the assignment component to give administrator privileges to any user. The name and date of the simulation, number of participants and email address are the required inputs. This component then communicates with the mail component to send a message to the user with login credentials and other required information.

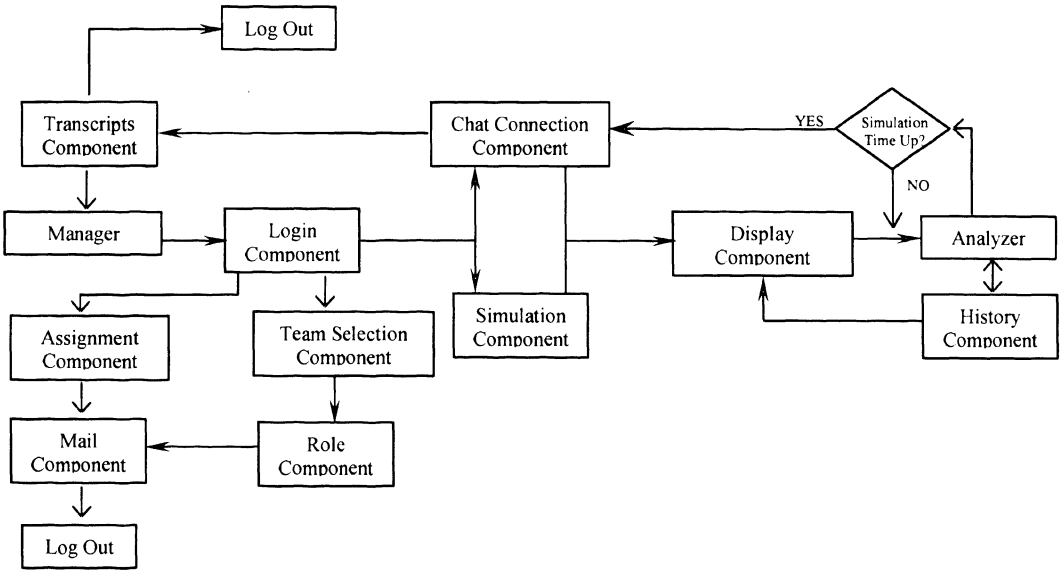

Figure 4.3: System Manager Flow Diagram

5. DISCUSSION AND CONCLUSION

Online access to role play simulations will allow users to be actively involved in the learning process. Students are more motivated by learning through practice and not by listening to lectures. The application generates interests with interactions among the various components in the backend and provision of required material. The user flow diagrams show that the user can learn in an interactive web environment rather than in a classroom. Moreover, the virtual facilitator improves the effectiveness of team meetings by automating the facilitating process.

An important advantage of this system is that it can be accessed from anywhere in the world. Thus, research on team dynamics or team training can be done with a diversified student community. The use of open source technologies will also ease the development of future applications. At the end of a simulation, user feedback is collected online. This survey helps improve the knowledge base of the system, making its interventions in team discussions more robust and intelligent.

Future work will incorporate more rule-based engines based on various theories of effective team dynamics. The system requires improvement with respect to processing speed and linguistic ability. The development and deployment of diverse role play simulations in various fields such as project management and finance will foster improved learning in many areas. This diversity will increase the scope of this project and allow researchers and educators to target various student groups around the globe.

6. REFERENCES

[1] Anne-Françoise Rutkowski, Doug Vogel, Michiel Van Genuchten And Carol Saunders, "Communication in Virtual Teams:Ten Years of Experience in Education," IEEE Trans. Prof. Commun., vol. 51, no. 3, pp. 302–312,Sept., 2008.

[2] E. Seat and S. M. Lord, "Enabling Effective Engineering Teams: a Program for Teaching Interaction Skills," Journal of Engineering Education, Oct., 385-390, (1999).

[3] Steve E Watkins, Ray Luechtefeld, Vijay Rajappa, "Communication and Teamwork Training Using an Engineering Simulation Game", Innovations 2006: World Innovations in Engineering Education and Research, edited by W. Aung, (iNEER, Arlington, VA, 2006).

[4] J. Wolfe, "The Effectiveness of Business Games in Strategic Management Course Work," Simulation and Gaming, 28, 360, (1997).

[5] T. Rosennorn and L. B. Kofoed, "Reflection in Learning Processes through Simulation/Gaming," Simulation and Gaming, 29, 432, (1998).

[6] J. B. Keys and J. Wolfe, "The Role of Management Games and Simulations in Education and Research," Journal of Management, 16, 307-336, (1990).

[7] A. J. Faria, "A survey of the Use of Business Games in Academia and Businesses," Simulation and Gaming, 18, 207-224, (1987).

[8] D. C. Thatcher, "Promoting Learning through Games and Simulations," Simulation and Gaming, 21, 262-273, (1990).

[9] C. R. Prohaska and E. J. Frank, "Using Simulations to Investigate Management Decisions Making," Simulation and Gaming, 21, 48-57, (1990).

[10] W. B. Gamson, "SIMSOC at 30," Simulation and Gaming, 25, 207-211, (1994).

[11] Susan Bull, Steven Quigley and Andrew Mabbott, "Computer-based formative assessment to promote reflection and learner autonomy", Engineering Education, Vol. 1, no.1, 2006

[12] Riley F, "Understanding IT: Developing multimedia Courseware" (UCoSDA, 1995), ISBN 1-85889-099-3), p8

[13] Jones.A, Petre. M, "Computer based Practical Work at a distance- a Case Study", Computers and Education, 1994, 22, (1/2), pp.35-36

[14] Ray Luechtefeld, Steve E. Watkins, and Raj Kanwar Singh, "Expert System for Team Facilitation using Observational Learning," paper presented at the Frontiers In Education Conference, 10-13 October 2007 Milwaukee, Wisconsin

[15] Smith, Daniel E.; Nair, Ravi. "The Architecture of Virtual Machines". Computer (IEEE Computer Society) 38 (5): 32–38 (2005).

2. DEVELOPMENT OF VIRTUAL TOOLS TO ENHANCE TEAM FACILITATION

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ABSTRACT

Students face problems related to effective communication, conflicts, and decision making in their group collaborations. This paper describes a tool that can help students handle these problems. This tool uses a role play simulations that engage students in real-life scenarios to help them gain a practical, as well as a theoretical, understanding of how to work effectively as a team. Students play roles in the simulations to learn about team dynamics. To assist students in their discussion, a virtual facilitator is incorporated into the system to intervene in the student discussions and resolve conflicts or aid the communication process. The rule-based engine of the facilitator system enacts various approaches to conflict management and effective group rules. This computationally intelligent tool is available online for the benefit of students working all over the world. This intelligent and interactive tool can help improve dynamics within student teams across the globe at low cost.

1. INTRODUCTION

Technologies to facilitate group interaction have been used for almost two decades. These range from very informal applications used by friends, families and social groups, including chat rooms, bulletin boards, and threaded discussions, to formal workplace applications for meetings and decision making, such as video conferencing [1]. These tools provide platforms for formal and informal discussions, but participants need effective communication and decision making skills to reach their goals during a meeting. Ineffective meetings waste time and energy.

The ancient Chinese philosopher Lao Tzu noted: "If you tell me, I will listen; if you show me, I will see; but if you let me experience, I will learn." A 2006 study by Baca, Watkins and Luechtefeld shows that a high degree of openness and interdependence is needed for students to improve the quality of decision making [2]. Effective team communication skills may not be taught in a classroom setting or by merely assigning students to teams [3, 4]. Several studies have shown however, that practical experiments in scientific and technological fields can influence student learning [5].

One approach to improve the performance of individuals in teams is to use role play simulation games. Such games have been used in other disciplines to teach skills and supplement instructional activities. They can engage students in situations that may not arise or may be difficult to incorporate in other educational experiences. For example, business simulations are well developed for teaching management skills [6-12]. The use of simulation games allows an individual to interact in a complex management

environment and to collaborate on solutions to technical problem. Research shows satisfactory results for an individual who is involved in an instructional game based on an engineering context by improving the relationship between team and individual goals [4].

Traditional role play simulations can present real-time scenarios, but they cannot help students in conflicts or monitor their agenda. According to a survey by D. Boud, R. Koegh, and D. Walker [13], professionals agree that 25% of meeting time is generally spent discussing irrelevant issues. To improve meeting performance, external interventions such as facilitators and training experiences are commonly employed. Informal social groupings tend to rely upon a moderator to ensure that appropriate codes of conduct are followed to [14], whereas more formal meetings require more skilled and experienced facilitators. Facilitators are unbiased and provide non evaluative feedback to participants [15]. There are two key problems associated with the use of facilitators: First, skilled facilitators are not widely available. Second, bringing geographically dispersed individuals into one discussion room is expensive [16].

Much of the current research in group dynamics is directed towards the use of computerized services. There is a great emphasis on facilitation combined with computer supported meetings [15, 16]. Automated facilitation tools may provide a simplified model for conversational interventions, which students can imitate [17]. Such software tools can better accommodate users in different geographical locations if they are available on the World Wide Web.

One benefit of integrating simulations into a website is the reduced learning curve imposed on users, who would otherwise have to familiarize themselves with a separate simulation package. The website can function as a general-purpose interface, and a variety of very different simulations can all be available in the same environment [18]. Additionally, a computer facilitator, the virtual facilitator, can observe conversations and coach participants without any prejudice.

This paper describes one such application, which incorporates different role play simulations that emulate different real time scenarios. It explains about the intelligent and interactive facilitator with two rule based engines which intervene in team conversations and conflicts. This paper also discusses about administration of the users and their access to the various levels in the system.

2. SYSTEM MODEL

The architecture of the system is divided into two segments. One part administers the simulation, and the other facilitates team communication using a chat interface. The administration of the simulation is a simple user interface that connects a user to the simulation game; this is called the web interface. The chat interface and the web interface are built with Java and J2EE, with MySQL server acting as the database server.

Users of the system are categorized into three levels. The system manager is the only user at the top level. This user can access all the components in the application and assign administrator privileges to other user. Administrators belong to the middle user level. They can invite users to participate in the simulations. Administrator privileges are limited. They set up the meeting time and date and divide the participants into teams. The users who are invited to participate in the simulation games are called participants. They belong to the bottom level of the hierarchy. Participants can join the simulation game only during the time specified by the administrator.

The user flow in a web interface begins when a user logs into the system. If the user is a participant, then he or she goes directly to the assigned simulation game room, where the system provides a briefing on the simulation. If the user is an administrator, then he or she may choose to join the role play simulation by the selecting a simulation game room. Otherwise, an administrator can invite more participants by specifying a new meeting time and date and setting up a mode of facilitation for each game room. The modes of facilitation will be explained section 5. Apart from the administrator user flow, the

system manager has an additional option to invite administrators for different simulations.

The user flow in the chat interface begins from the moment a user joins the simulation. The game room is a Java Applet chat room. Messages entered into the chat application are processed by a rule-based engine in the server. This intelligent engine is the virtual facilitator. Based on various modes of facilitation, triggers are identified and output for the facilitator is generated. The facilitator messages and the corresponding user messages are saved for future reference in the server history. All chat conversations are saved and sent to administrators and participants. The chat interface is the same for all participants.

3. ADMINISTRATION

The role play simulation application is deployed on a web server. Online access to the simulation allows users to be actively involved in the learning process. The interaction of the various components in the backend of the system and the material sent to the user help to generate interest in the use of the application.

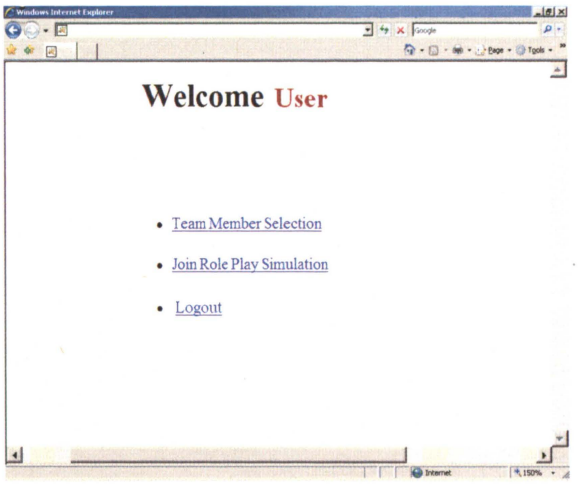
This online tool requires no special installations; it runs on any operating system. The software is developed on a Java®™ platform. Therefore, a Java virtual machine must be installed. This tool requires at least one web browser, but any browser can be used. Microsoft® Internet Explorer®™ is currently the browser most compatible with this software.

The login screen is the first page a user encounters when accessing the simulation tool. The user's email address and password are necessary to log into the application. Login credentials will be sent to the user by the simulation administrator. The login credentials are valid only at the date and time of the simulation, and they remain valid for the duration of the simulation. For administrators, login credentials remain valid from the day administrator privileges are given, and they end on the date specified by the system manager.

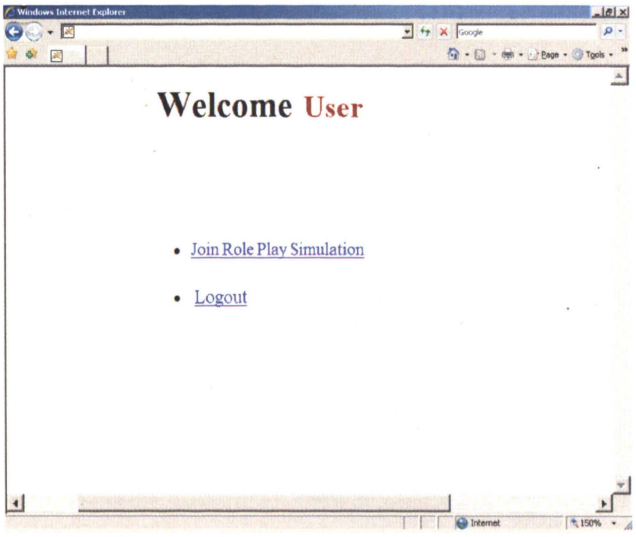
Figure 3.1: Login Screen

The screen shown in Figure 3.2 appears based on the user level. From this screen, participants can join a simulation game or log out. If a user clicks 'Join Role Play Simulation' a briefing is displayed about the role he or she is going to play in the simulation. A detailed explanation of the simulations is provided in Section 4. Prior to signing in, participants receive an automated email from the administrator providing the login credentials, date and time of simulation, team number, and name of the simulation game.

System Manager Screen



Administrator Screen



Participant Screen

Figure 3.2: Home Page Screens for Various User Types

The system manager can assign an administrator using the 'Assign Local Administrator' option. An instructor who wants to work with students on team dynamics or group

collaborations can request that the system manager assign him as the administrator. The details needed to assign the user as an administrator are the number of participants, the role play simulation to perform and the end date for the permissions. With these details, the system manager can fill out the form shown in Figure 3.3. An automated email is then sent to the individual with details of the request.

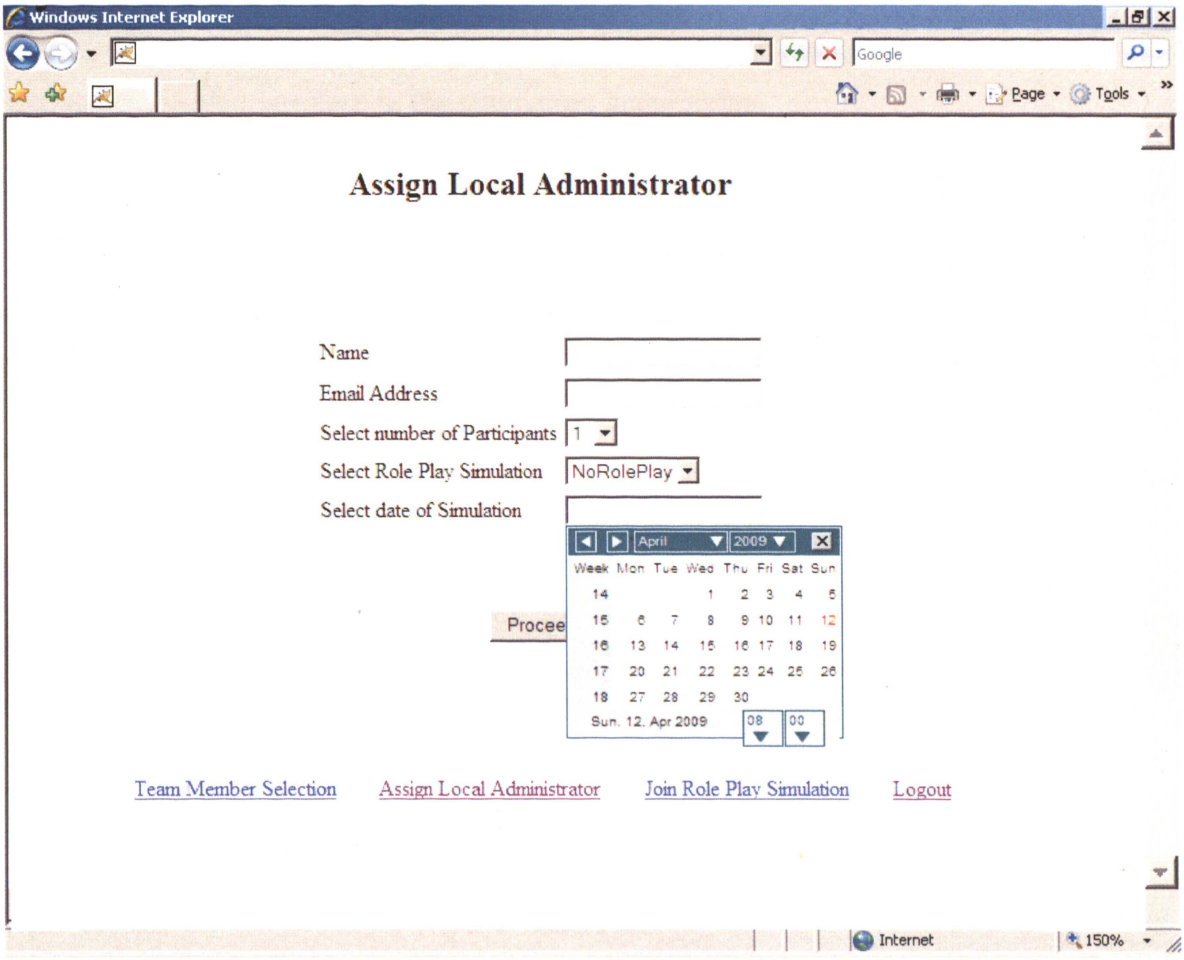


Figure 3.3: Administrator Selection Screen

The administrator can select the 'Team Member Selection' option to assign the participants to teams. Figure 3.3 shows the user interface for the assignment operation. The number of participants and the type of simulation cannot be changed, but the administrator can select the number of teams and the date, time, and duration of the simulation. Administrator can also choose whether to send participants their chat transcripts. After proceeding to the next page, administrator must enter each participant's name and email address and select the team number and mode of facilitation. (The mode of facilitation will be described in section 5.) The mode of facilitation will load the settings in the chat interface in the simulation game room.

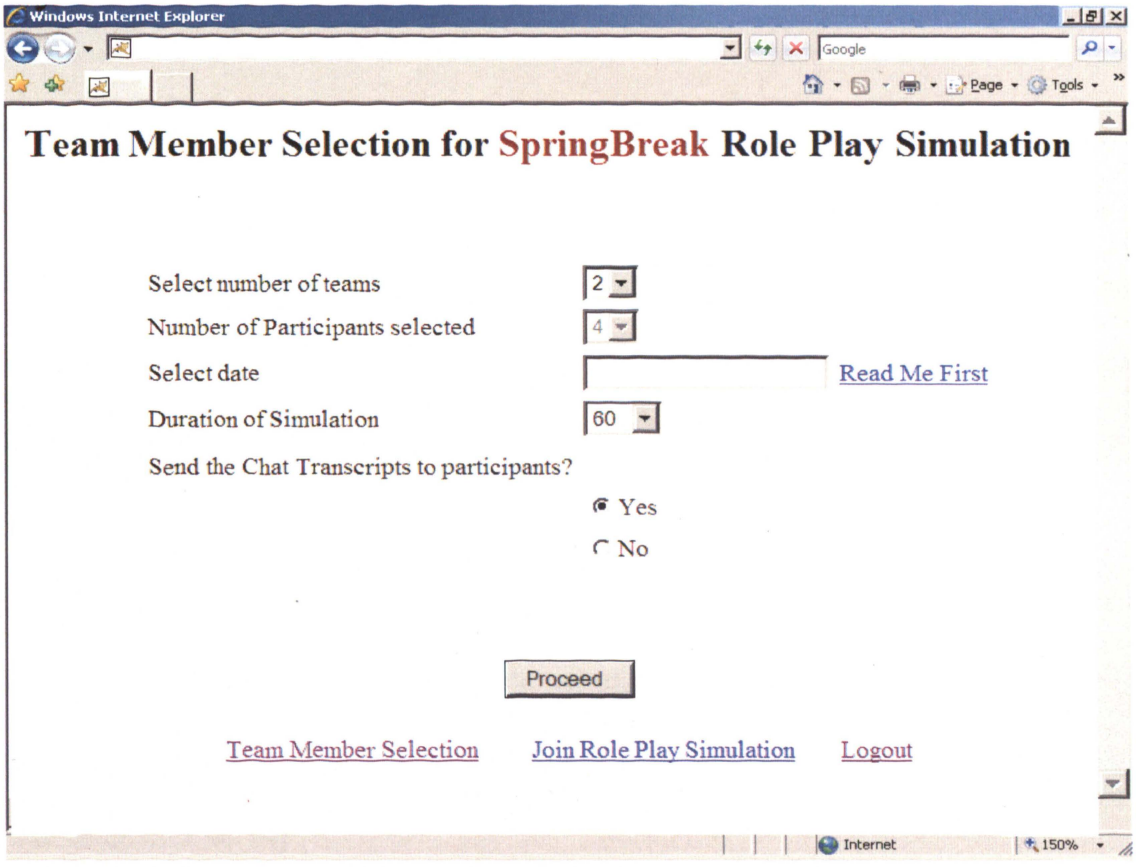


Figure 3.4: Team Member Selection Screen

4. ROLE PLAY SIMULATIONS

Simulation games create a tailored environment in which a group can interact and communicate. They provide an opportunity to tie context to the desired knowledge with an exercise that is fun and holds the interest of participants [19]. Educational games have value because they engage students in realistic group dynamics while lowering considerations of ego (since it is "only a game"). They also provide opportunities for reflection on specific actions taken by players without the grading or evaluation pressures that can negatively affect project work and other traditional learning assignments.

The training concepts that the game illustrates are the interrelation of individual and team goals and associated skills in communication and interpersonal relationships, e.g., bargaining, listening, and conflict resolution. Although the game itself does not present approaches or tactics to improve these skills, it does provide an opportunity for students to participate in realistic team discussions requiring these skills. Since the teams communicate in a chat room, a transcript is available for review by students and debriefing by the instructor [4].

When the administrator invites others to join the simulation, participants are randomly assigned to specific roles. The number of roles available is based on the type of simulation. When the participant logs into the system, the system provides the description of the assigned role. [4]

Each player has a distinct technical role with sole access to a subset of the technical options. Individual goals and limitations are specified in terms of these technical options. The range of options for each technical design decision involves trade-offs among all players, i.e., higher performance in one area lowers performance in another area.

If consensus is not reached on at least the lowest-level goals for any player, a fallback option is forced on the team that is significantly degrades the design. All player communication is public, i.e., visible to by all players on a team. A record is kept for later analysis in the post-game debriefing and for student reflection.

The different simulation games incorporated in the website are:

Spring Break Simulation: This simulation is related to social loafing. A team of four members can participate in this simulation. Three members in the team are given $10,000 and asked to plan a trip for spring break. They are provided with their monthly schedule and information about lodging, tourist activities, and a selection of restaurant menus for breakfast, lunch, and dinner. The fourth person has a budget of $600. He is also given a monthly schedule and a description of the trip. The objective of this simulation is for all players to manage the trip and plan shared activities successfully.

Solar Car Simulation: This simulation involves sharing information from multiple disciplines. The goal of this game is to choose solar car components that maximize the number of miles the car is able to travel. Each team consists of four members, each representing one department. The mechanical department must suggest the type of motor

from a list of choices, the electrical department suggests types of batteries, and the frame design department suggests the type of frame and solar cell. Finally, the cost management department is charged with ensuring that the car does not exceed the budget. The participants are given thirty to forty minutes to conclude their decision.

Budget Balancing Simulation: This simulation is related to finance. Students participating in this game are given the task of balancing the budget of a fictional company to maximize profit. They should achieve this goal within thirty to forty minutes. Each team has four roles, with one member playing each role. The team consists of the union representative whose goal is to protect regular employee interests by limiting layoffs. The director of personnel, on the other hand, has to retain not only employees but also managers from various departments. The director of development and the director of finance want to retain employees and the managers of their own departments and they must ensure that they have sufficient funds for projects.

5. THE VIRTUAL FACILITATOR

5.1. DESCRIPTION

The virtual facilitator is an intelligent and interactive software system that incorporates features of an internet chat space. It has a dialogue box that lists the names of the team members. This box is automatically populated as the participants log into the simulation website. As with a typical chat tool, conversations appear in the dialogue box. This tool permits both keyboard chat and use of headsets. Voice recognition software is installed to convert speech to text. There is a separate dialogue box for facilitator messages.

Once the participant clicks the 'Join Role play simulation' link, he can join his team members and the virtual facilitator in the chat room.

In a face-to-face meeting, a human facilitator can observe the conversation on both audio and video channels. Facilitator looks for cues that may indicate a problem. Having observed a set of problem cues, the facilitator diagnoses the problem and intervenes in the conversation. The ability to find problem cues will improves with experience [1]. In a similar way, the virtual facilitator identifies and analyzes triggers in user statements. Based on the triggers received, it looks for the appropriate facilitator response from the knowledge base. Computationally intelligent software allows the program to "learn" to intervene more effectively.

The knowledge base is a simple rule-based engine with a list of triggers and ways they would be used in the conversation. It follows IF-THEN logic for choosing intervention

messages. Just as a human facilitator gains experience through involvement in conversations, so the virtual facilitator also learns from such conversations. The server history component stores possible triggers that for intervention. Rules for interventions can be repeatedly modified and improved.

The virtual facilitator stores team conversations to a file on the server. Each team discussion is stored along with the simulation name and name of the administrator. The messages also have time stamps. The transcripts are automatically mailed to the administrator. The administrator may also to choose to send transcripts to participants.

5.2. MODES OF FACILITATION

The virtual facilitator currently has three modes. Each mode has a different set of rules to respond to triggers in the user conversations. To learn about the modes of facilitation, a participant can type 'Computer help' in the text box of the chat window. All the modes are described below:

Normal Facilitator Mode: The administrator can select this mode of facilitation for a participant. Otherwise, typing in 'Computer facilitator' will activate it. In this mode, the rule-based engine seeks trigger words such as *clearly*, *obviously*, *can't*, *impossible*, *unable*, etc. It also analyzes statements involving advocacy and those indicating that someone is making or forcing another user to do some something [20]. For example, Student 'A' types in "Without me, it's impossible." This statement is processed by the rule-based engine and finds the trigger 'impossible' and asks, "Student A, What prevents

you from doing so? Does anyone see things differently?" If the participant statement is "I have to come to the movie tonight," the virtual facilitator will intervene by asking, "Student A, what leads you to see it that way?" In the last case, the trigger detected is 'have to,' which represents an attempt to force the group to accept his statement. Such interventions have been shown to improve the effectiveness of team communication [21].

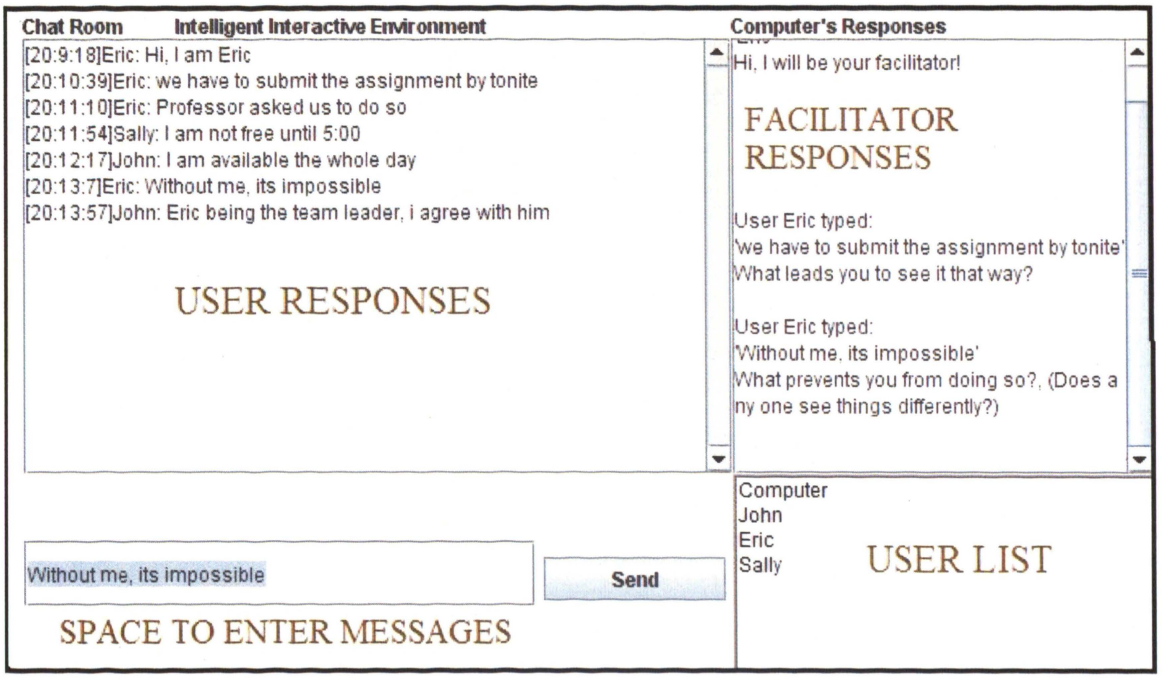


Figure 5.1: Facilitator Chat Window

Nonviolent Communication Mode: The administrator can select this mode of facilitation for a participant. Otherwise, typing in 'Computer NVC' will activate it. This approach to intervention is modeled after the process developed by Marshall B. Rosenberg to help student teams manage conflict [22]. The virtual facilitator will look for a negative connotation in the participant statements. When such statements are found, the

facilitator determines whether the statement is a value judgment. It then asks the participant to whom this statement refers. With this information, facilitator starts the nonviolent communication process with the two participants. It begins by asking for the facts that lead to this value judgment. When both participants agree about the specific facts, it asks for the participants' specific feelings and needs in this situation. Finally, the facilitator asks the participants to make a request of one another so that they can understand each other's feelings and needs.

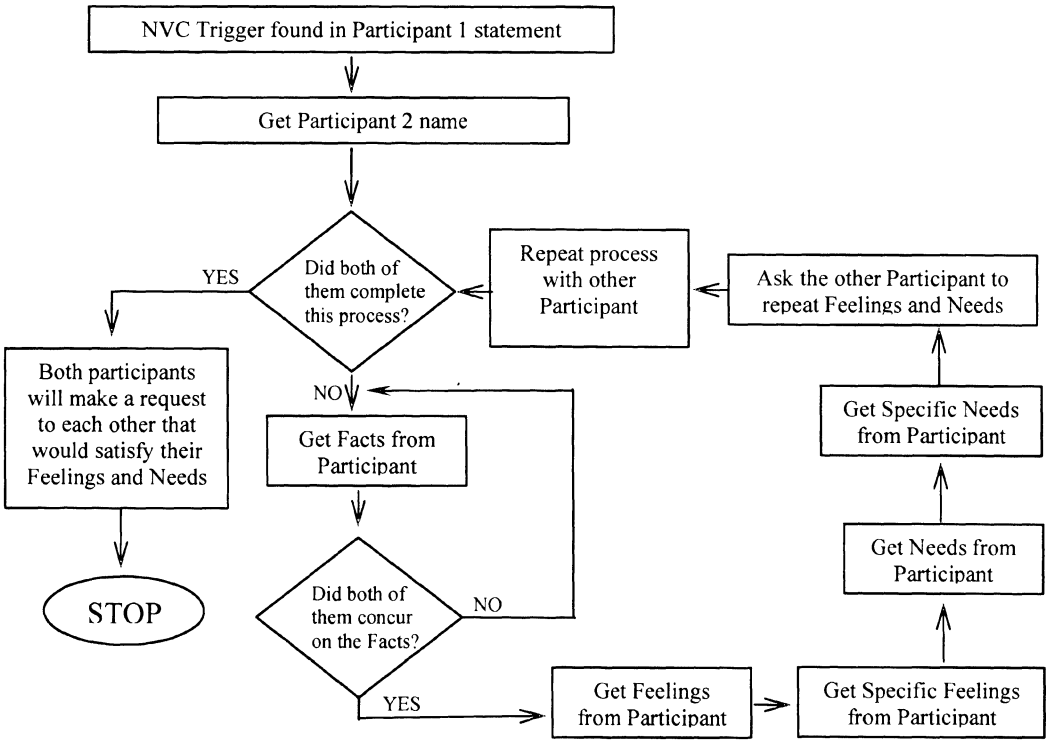


Figure 5.2: Flow chart for Nonviolent Communication process

No-Facilitator Mode: This mode can be activated by the administrator in the discussion room. Otherwise, typing in 'Computer stop' will activate this mode of facilitation. The facilitator will not intervene in the student conversations. It will just observe the discussions. In this mode, the application is like a typical chat application.

6. DISCUSSION

This online simulation tool enhances the student motivation by making them learn through practice and not by listening to lectures in classroom. The students try to learn effective team communication by imitating the facilitator interventions. The administrator can assist the virtual facilitator by providing his interventions during the team conversations. In this case, these interventions are not highlighted by displaying in facilitator interventions window. The facilitator interventions are not displayed privately to the user, but visible to everyone in the chat room. Especially, in NVC mode, conflict is resolved between two members while other team members can watch and learn the process. Other members can neither be involved in NVC process nor discuss their previous agenda.

The simulation tool assumes that the students are willing to improve their team dynamics using chat conversations. Participants can use headsets to talk to their team members and virtual facilitator wherein speech recognition software will convert speech to text. The student needs to invest extra time to get trained to this software. The facilitator interventions in both the modes assume United States of America's conversation style. In case of global teams, the system assumes that different cultures across the globe converse similar to that of United States. Also, global teams needs to login to the system according to the US Central time.

7. CONCLUSIONS

Test results indicate that a computationally intelligent online system will improve the performance of students in group collaborations. The advantage of a web version is that it can be accessed by geographically dispersed students. The virtual facilitator does appear to change student behavior using repetitive inquiry. The role play simulations help students to enhance their decision-making skills and focus to reach individual and team goals.

Team dynamics can be improved by periodic meetings using this tool. The diversity in student behavior can result in a variety of team-related and decision making problems. A consistent remedy for each type of team dynamics problem can be found by developing this tool. A medical analogy can be drawn between these real-time problems and untreated diseases. Student teams can be injected with disease like conflicts by designing various role play simulations. The interventions by the facilitator will treat these problems. Application of such treatment to many student teams will make the system consistent so that it can become a remedy available in all real-time scenarios.

Future work will develop more varied role play simulations that address a broader range of problems. Facilitator interventions are limited to certain triggers, its linguistic ability, therefore, should be improved. The virtual facilitator's interventions should be available by audio to give its presence greater impact. On a large scale, this tool permits researchers to address questions that would be difficult to answer using any other approach.

8. REFERENCES

[1] Macaulay, L.A. and Alabdulkarim, A., (2005) "Facilitation of e-meetings: State-of-the-Art review", Proceedings of the 2005 IEEE International Conference on e-Technology, e-Commerce and e-Service, Hong Kong, China, IEEE Computer Press, ISBN 0-7695-2274-2, pp 728-736

[2] Baca, D., Watkins, S.E., and Luechtefeld, R., (2006) "Patterns in Team Communication during a Simulation Game," Proc. of the 2006 ASEE Annual Confer, 18-21 June 2006 Chicago, Illinois.

[3] E. Seat and S. M. Lord, "Enabling Effective Engineering Teams: a Program for Teaching Interaction Skills," *Journal of Engineering Education*, Oct., 385-390, (1999).

[4] Steve E Watkins, Ray Luechtefeld, Vijay Rajappa, "Communication and Teamwork Training Using an Engineering Simulation Game", Innovations 2006: World Innovations in Engineering Education and Research, edited by W. Aung, (iNEER, Arlington, VA, 2006).

[5] Ernesto Granado, William COlmenares, Miguel Strefezza, Alfonso Alonso (2006) "A web-Based Virtual Laboratory for Teaching Automatic Control," Wiley Periodicals Inc., August 2006.

[6] J. Wolfe, "The Effectiveness of Business Games in Strategic Management Course Work," Simulation and Gaming, 28, 360, (1997).

[7] T. Rosennorn and L. B. Kofoed, "Reflection in Learning Processes through Simulation/Gaming," Simulation and Gaming, 29, 432, (1998).

[8] J. B. Keys and J. Wolfe, "The Role of Management Games and Simulations in Education and Research," Journal of Management, 16, 307-336, (1990).

[9] A. J. Faria, "A survey of the Use of Business Games in Academia and Businesses," Simulation and Gaming, 18, 207-224, (1987).

[10] D. C. Thatcher, "Promoting Learning through Games and Simulations," Simulation and Gaming, 21, 262-273, (1990).

[11] C. R. Prohaska and E. J. Frank, "Using Simulations to Investigate Management Decisions Making," Simulation and Gaming, 21, 48-57, (1990).

[12] W. B. Gamson, "SIMSOC at 30," Simulation and Gaming, 25, 207-211, (1994).

[13] D. Boud, R. Koegh, and D. Walker, "Reflection: Turing Experience into Learning", Kogan Page, London, 1988.

[14] J. Preece, Online Communities: Designing Usability, Supporting Sociability. Chichester, UK: John Wiley and Sons, 2000

[15] Fabio Pianesi, Massimo Zancanaro, Vera Falcon, Elena Not, "Toward supporting Group Dynamics", Proceedings of AIAI'06, June 2006

[16] Macaulay, L.A., Alabdulkarim, A.,and Kolfschoten, G., (2006) An Analysis Of The Role Of The Facilitator And Alternative Scenarios For Collaboration Support, Hawaii International Conference on System Sciences, HICSS-39, January 4-7, 2006

[17] Luechtefeld, R., Watkins, S., E., and Flori, R., "Automated Discourse Interventions and Student Teaming," Proceedings of the Frontiers in Education Conference, 19-22 October 2005, Indianapolis, Indiana.

[18] Ann M. Masson., "We-based simulations for computer-assisted learning in the higher education sector," Engineering Science and Education Journal, June 1999

[19] A. C. Burns and J. W. Gentry, "Motivating Students to Engage in Experiential Learning: A Tension-to-Learn Theory," *Simulation and Games*, **29**, 133, (1998).

[20] Ray Luechtefeld, Steve E. Watkins, and Raj Kanwar Singh, "Expert System for Team Facilitation using Observational Learning," paper presented at the *Frontiers In Education Conference*, 10-13 October 2007 Milwaukee, Wisconsin (refereed)

[21] R. Schwarz "The Skilled Facilitator", San Franscisco, Jossey – Bass Publishers, 1994

[22] http://www.cnvc.org/

APPENDIX - I

EFFECTS ON GROUP BEHAVIOUR

A small number of experiments have been conducted using the virtual facilitator in conjunction with the solar car and business budgeting simulations. The simulations were given as handouts to students. Each experiment was conducted with two groups. First, a treatment group was exposed to the normal facilitator mode in the discussion room, and the control group used the no-facilitator mode. Two significant results were found [21]. First, participants exposed to the system asked more questions of others in their team than the teams which are not exposed to facilitator interventions. Table 1 shows the results.

Table 1: Results - Number of Questions Asked

Type of Simulation Game	**Type of Group – Team #**	**# of Questions Asked**	**Difference (Treatment - Control)**
Solar Car (Project Management)	Treatment – Team 1	83	10
	Control – Team 2	73	
Business Budgeting (Business Logistics and System Analysis)	Treatment – Team 1	37	11
	Control – Team 2	26	
	Treatment – Team 1	31	2
	Control – Team 2	29	
Business Budgeting (Psychology)	Treatment – Team 1	26	5
	Control – Team 2	21	

Secondly, quantitative performance and decision making was greater with the treatment team than with the control team (See Table 2). Team performance was measured by evaluating which team reached a greater number of miles/day (in the solar car simulation) and which team made more profit (in the budget balancing simulation) by reaching consensus without violating the rules. Participants exposed to the system exhibited greater ability to deal constructively with conflicts.

Table 2: Results – Quantitative Performance

Type of Simulation Game	**Type of Group – Team #**	**Decision Reached**
Solar Car (Project Management)	Treatment – Team 1	346.9 miles/day
	Control – Team 2	352.4 miles/day
Business Budgeting (Business Logistics and System Analysis)	Treatment – Team 1	Loss $11,950
	Control – Team 2	Loss $17,000
	Treatment – Team 1	Loss $11,200
	Control – Team 2	Profit $5,000
Business Budgeting (Psychology)	Treatment – Team 1	Loss $10,000
	Control – Team 2	No Consensus Reached

APPENDIX - II

USER MANUAL

This section provides a guideline on how to navigate and use the Role Play Simulation website. To access it, user has to go the following website.

http://facilitator01.srv.mst.edu:8080/roleplay

SYSTEM REQUIREMENTS

- The software runs on any Personal Computer, Laptops etc. There is no restriction on the operating system.
- The software is developed on Java®™ platform. Hence, Java virtual machine must be installed before user starts using it.
- There should be a web browser to use this tool. Microsoft® Internet Explorer®™ is best compatible with this software. Otherwise, it works on any browser.

LOGIN

- The Login screen asks for Username and Password. All users need to have login credentials. The username will be email address.
- User can login only at a particular date and time of the simulation set by the administrator.
- The login credentials will be sent via email to user by the administrator.
- A link is available if user forgets the password. Upon clicking the link, user can enter his/her email address. Then, password will be sent automatically to the email address only if the email exists in the database.

ADMINISTRATOR

- The administrator privileges are given to the user who would be the conducting the Role Play Simulation. User can administer the Role Play Simulation upon contacting Dr. Ray Luechtefeld (luechtef@mst.edu), the System Manager.
- The administrator needs to specify the number of participants involved in the simulation. Administrator also has to decide on which simulation he will be using with the participants. He needs to specify the end date of the simulation activity as the permissions to the user will be given till that specified date. An automated email will be sent after permissions being set.
- After logging in to the website, administrator has three choices -To assign participants to various teams, join the role play simulation or to logout. This section describes only about the *Team Member Selection.*
- After navigating to this page, administrator can get to select the number of teams he want to divide the participants into. Also, the page displays the simulation type selected and the number of participants requested.
- Administrator can select the date, time and duration for the simulation for the participants.
- Administrator can toggle the chat transcripts feature for the participants. If chooses to *yes,* then the chat transcripts are send to participants otherwise they are sent only to administrator after the simulation.
- The administrator can decide on the various modes of the facilitator. The description of various modes is given in further sections.

- Administrator has an option to send the transcripts to all the participants after the simulation.
- Upon navigating to the next page, administrator can enter the name and email address of the participants and assign them the respective teams. Administrator can also choose the mode of facilitation for a team.
- Upon clicking "*proceed*" button, a confirmation message appears that the participants are invited. An automated email will be sent to the participants giving the details of the simulation, team number and login credentials.

PARTICIPANT

- To participate in the role play simulation, the user needs to get an email address invitation via the administrator the simulation.
- The email address has a link to the website, login credentials, team number, simulation name, name of the administrator and date and time of the simulation.
- The participant login credentials will be valid only through the duration of the simulation set by the administrator.
- After logging in to the website, user has a two choices – Join Role Play Simulation or to logout.
- The needs to go click on the *Join role play simulation* to take part in the simulation. The usage of it will be explained in the next section.

JOIN ROLE PLAY SIMULATION

- User enters into intelligent chat room when user navigates to "*Join Role Play Simulation*". This webpage appears with a chat window and a link to read the instruction manual for the game. Also, a popup is appeared with the same instruction manual for the game.
- For an administrator, a list of rooms is displayed before he can see the chat window. Selecting his choice of room will direct him to the respective chat room.
- The chat window has user list window, facilitator messages window, text area and user discussion window.
- The user list window displays the list of users currently participating in the simulation. The discussions can be entered through the text area and will be visible in the user discussion window. If the facilitator intervenes in the conversation, these messages are displayed in the facilitator window.
- The administrator decides on the mode of facilitator operation. All users can switch between the various modes, only on administrator consent.
- The facilitator operates in the following modes:
    - **Normal Facilitator**: In this mode the facilitator will be clarify the discussions with Chris Argyris's theory of effective communication. The command to activate is "*computer facilitator*".
    - **Compassionate Communication (NVC)**: This mode deals with conflict management theory of Marshall Rosenberg. This mode resolves a conflict between the two participants at a time. The command to activate is "*computer nvc*".

- **Stop Facilitator**: In this mode the facilitator will not intervene in the conversation, unless any of the command above is activated. The command to activate it is "*computer stop*".
- **Help**: This mode displays all the commands that user can use with the facilitator. The command to activate this command is "*computer help*".

- All the users along with the administrator need to type the command, if they want to switch between various modes.
- A link to the instructions document is also provided next to the chat window. The document has detailed instructions about the role of the participant in the simulation. This document varies depending on the role of the user.

VITA

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He worked with Dr. Ray Luechtefeld in his area of interest. During his research, he designed and developed web facilitator software using role play simulations. He completed his research under Dr. Ray Luechtefeld, being the author of two conference papers. He received his Master of Science Degree in August of 2009.