Games for Team Training

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ABSTRACT

Team building has become an important organizational development intervention. It is used to train individuals to work together. The aim of team building is to improve team performance while achieving an organizational goal. Team building activities are based on meaningful games that require the members of a team to cooperate in order to accomplish a specific task. Usually, the members of a team are in the same physical location when they perform a task. However, there are also teams comprised of members who are not always in the same place at the same time. We have designed, developed and are currently testing a virtual world that supports team building activities for teams that are geographically dispersed. Virtual worlds create the illusion of a real environment in which individuals perceive themselves as existing within that environment. Virtual worlds also allow people to share the same environment, to interact and to talk. We conducted an experiment in order to demonstrate that virtual worlds can be effectively used for team building activities. We first recruited twenty-five college students and randomly assigned them to five teams (five subjects per team) and two groups. The first group (called the "real group") performed a team building activity in a real setting while the second group (the "virtual group") had the opportunity to perform the same activity in a virtual world first. Using standardized tests, we measured team performances, collected data on team cohesion and asked the participants to evaluate their experiences. The virtual group performed better than the real group. The team cohesion results were similar among the two groups. The results are presented and discussed in this article.

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INTRODUCTION

Team building activities are frequently used inside organizations to establish and develop a greater sense of cooperation and trust among employees. Interactive exercises, team assessments, and group discussions enable groups to cultivate a sense of teamwork. Huse (1980) defines team building as the process of helping a work unit become more effective in accomplishing its tasks and in satisfying the needs of group members. Beer (1980) identifies team building as a process by which members of a group diagnose how they work together and plan changes which will improve their effectiveness. Based on another research study (Dyer, 1977) team building activities are defined as interventions conducted in a work unit as an action to deal with a condition that needs improvement.

Beer (1976, 1980), Dyer (1977), and Buller (1986) propose to distinguish among team building activities based on their focuses: goal setting, interpersonal relations, problem solving, and role clarification. Goal setting team building interventions involve the team members in planning and identifying ways to achieve the desired goals. Interpersonal relations based team building develops trust and confidence among the team members, and problem-solving team building interventions involve team members in action planning. Finally, role-clarification team building interventions seek to achieve a better understanding of team member's roles and duties. Regardless of their focus, research studies show that team building activities lead to an increase in team performance (Shandler and Egan, 1996).

In literature there are several research studies that show that cohesive teams perform better than non-cohesive teams (Walfe, Bowen, Roberts, 1989; Jaffe, Nebrenzahl, 1990; Liedtka, 1989). Cohesion can be considered the attraction of team members to the group (individual attraction to the group) and it can be measured by evaluating how much members of the team like each other (social cohesion) and by how long they want to stay in the same group (Hogg, 1992). Research studies indicate that cohesion is also related to the commitment of the group to the task (task cohesion) (Mullen and Copper, 1994).

Team building activities are usually designed by taking into consideration that the team members will be together at a specific time in the same, shared environment. However, businesses tend to scatter their employees in different home locations, cities even overseas. Due to the increased cost of traveling, employees have to find ways to work together with colleagues from different locations without being face-to-face. Pascual et al. (1999) call such teams group-distributed teams. Distributed teams can be defined as teams geographically dispersed such that they do not have direct face-to-face contact with each other.

A large amount of literature on geographically dispersed teams has emerged over the last decade (Powell et al. 2004; Wiesenfeld et al. 1999). Researchers have determined that the factors that help geographically dispersed teams to achieve high performance are: training (Kaiser et al., 2000; Tan et al., 2000), strategy/goal setting (Kaiser et al., 2000; Malhotra et al., 2001), developing shared language (Majchrzak et al., 2000a), team cohesiveness (Maznevski & Chudoba, 2001), communication (Kayworth & Leidner, 2000; Maznevski & Chudoba, 2001; Suchan & Hayzak, 2001), and coordination and commitment of the team (Maznevski & Chudoba, 2001).

Virtual enviroments can overcome issues related to the training of geographically dispersed teams. According to Edgar Dale's cone of learning (1969) the largest portion of learners tend to remember material when they actively simulate a real experience. However, more research that focuses on clarifying if people can transfer to real practice what they have learned in a simulated environment is needed. The goal of the project described in this paper is to verify that teams who practice in a virtual world before performing in a real world situation achieve better results than teams that do not have the opportunity to practice. A secondary goal of the project was to investigate the effect of the simulation on team cohesion. Our

hypothesis is that the teams that practice in a simulated world will perform better when required to execute the same activity in the real world. Our secondary hypothesis was that the team level of cohesion would not be significantly different between the simulated and the real activities.

METHODS

In order to compare the performance of each team we selected a team building activity that could easily be executed in both the virtual and the real world. The activity required members from each team to step onto thirty markers with both feet in a sequential order from 1 to 30, as quickly as possible. The markers were randomly placed on the floor in a 15x30 foot room in the real world and in a hotel court yard in the virtual world. When a member of a team jumped onto a marker, he/she had to call out to their teammates the number they stepped on. The teams had ten minutes to execute this task. During this time frame, they were allowed to improve their performances by trying new strategies. The teams had the opportunity to plan their strategy before an attempt. They could change strategies as many times as they wanted. We considered a mistake to have occurred when a member of a team stepped on a marker in the wrong sequence or when a different number than the one written on the marker was called out. If a mistake happened the entire team had to start over from the beginning.

There were two groups: the virtual group and the real group. Two teams were in the virtual group (Virtual 1 and Virtual 2), while three teams were in the real group (Real 1, Real 2 and Real 3). Each team had five randomly assigned subjects and the teams were randomly assigned to the real or virtual group. We designed three team building activities. The thirty markers were placed in different positions for each of the activity. There were two activities in the real world (R1 and R2) and one in the virtual world (VR). Each of the groups had to perform the two activities in the real world while the virtual group had the opportunity to practice a similar activity in the virtual world first before performing it in the real world. Figure 1 shows a diagram of the experiment.

We videotaped the real world activities and we video captured the virtual activity for post experiment analysis that included a verification of the time span for each performance. The Visual Analogue Scale (VAS) questionnaire and a questionnaire about level of team cohesion were collected at the end of each activity. Demographic information was collected at the beginning of the experiment. This experiment received approval from the Institutional Review Board of Old Dominion University and the subjects signed an informed consent and a video release form before starting the experiment. Figure 2 shows both the virtual and the real experience for one of the teams.

Improving performance

Groups	VR	R1	R2
Virtual Groups	X	X	X
Real Groups		X	X

Figure 1. Study design

Measurements

We used two questionnaires that were validated in previous research studies. We administered the two questionnaires immediately after each of the three activities.

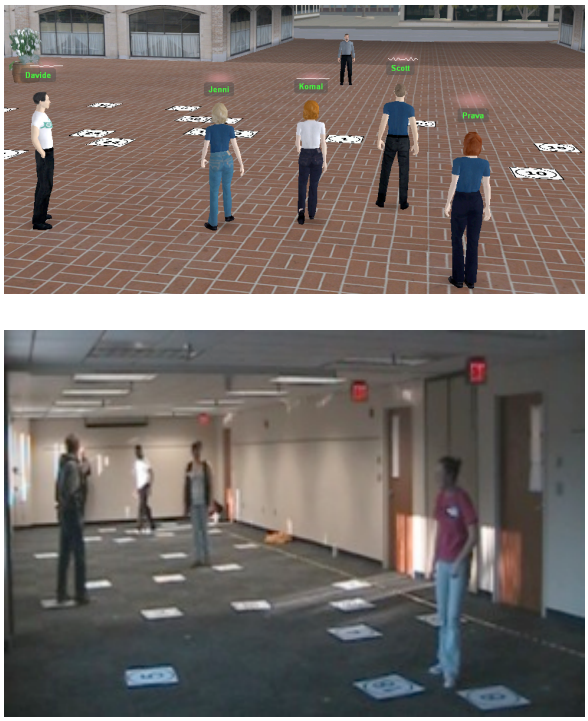

Figure 2. Virtual and real activities

The Visual Analogue Scale (VAS) (Gross & Levenson, 1995) is a self-reported questionnaire that measures a characteristic or an attitude that cannot be directly

measured but that is believed to range across a continuum of values. An example of non-measurable values is the amount of pain that an individual experiences; only the person who is suffering the pain can quantify it. VAS questionnaires can also be used for studying other non-measurable variables such as skills, confidence, and quality of teamwork. In this study the VAS questionnaire was presented with six different faces that ranged from "Delighted" represented by a smiling face to "Terrible" represented with a sad face. The subjects were asked to indicate what face best described the level of playfulness they experienced during the last activity.

The Group Environment Questionnaire (GEQ) (Widmeyer, Brawley&Carron, 1985) was developed and validated to assess cohesion on sport teams. The GEQ assesses the four types of cohesiveness, three of which were adapted for this particular study as shown in Table 1. The GEQ contains 18 questions measured on a 1 to 9 point Likert scale that ranges from strongly agree to strongly disagree. Although it was developed for sports teams, Dion and Evans (1992) pointed out that such an approach could be applied to different types of groups. In our study, the 18-item GEQ was adapted for work teams according to Carless and DePaola (Carless, S. A., & DePaola, C. 2000) to reflect an organizational environment instead of a sports context and the number of questions was reduced to seven.

The first three questions focused on task cohesion, the second three on social cohesion and the last questions provided insight into the individual's attraction to the group. Table 1 shows the questions in detail and the three dimensions of cohesion to which they belong.

Virtual world

For the virtual world we used a multi-player, online, virtual environment team trainer solution called Games for Team Training (GaMeTT). Before starting the experiment, we trained the team members of the virtual group in a conference room on the basic skills (how to talk and how to move) needed to be able to navigate inside the virtual environment. We also gave them a "cheat-sheet" with information on how to move in the virtual world using the keyboard and mouse. During the experiment, each of the subjects was physically located in a room by themselves.

Although GaMeTT requires each individual to log in, we had previously logged in each of subjects. After a 10 minutes training session, each subject was directed to a separate room which contained a laptop and headset. Then each subject joined the team to engage in the virtual activity. A member of the research team was present in the virtual world and he provided directions on the activity. The same directions were given to the teams only performing in the real world. In order to maintain a realistic experience we used an avatar for each of the subjects with their same gender.

Type of cohesiveness	Task Cohesion	Social Cohesion	Individual Attraction to the group
1. Our team is united in trying to reach its goals for performance	X		
2. I'm happy with my team's level of commitment	X		
3. Our team members have conflicting aspirations for the team's performance	X		
4. Our team would like to spend time together outside of work hours		X	
5. Members of our team do not stick together outside of work time		X	
6. Our team members rarely party together		X	
7. Some of my best friends are in this team			X

Table 1. The Group Environment Questionnaire for measuring cohesion

Demographics

Subjects were recruited at Old Dominion University. Selection criteria were: 1) 18 years of age or older; 2) able to walk/run for ten minutes; 3) able to use a keyboard and mouse; 4) English speaking. Table 2 shows details about the demographic characteristics of the subjects. Ten subjects (two teams) composed the virtual group while the real group had fifteen subjects (three teams). One of the subjects did not report age information in the demographic questionnaire. The subjects in the virtual groups were slightly older than the subjects in the real groups. However, both groups reported a similar level of experience with team building activities. Such activities were related to experience at Scout camps and military training exercises. Both groups had subjects of different genders.

	Age (years)						Gender		Previous team building activity	
	<20	**20-25**	**26-30**	**31-35**	**>35**	**n/a**	**M**	**F**	**Yes**	**No**
Virtual Group	0 0%	6 60%	2 20%	1 10%	1 10%	0 0%	4 40%	6 60%	3 30%	7 70%
Real Group*	6 40%	8 53%	0 0%	0 0%	0 0%	1 7%	7 47%	8 53%	3 20%	12 80%

* One data on age was not reported by one subject.

Table 2: Subject demographic characteristics presented by groups

RESULTS

Table 3 shows the VAS results for each of the activities for the two groups. Four Virtual group subjects (subjects 4, 5, 6 and 7) reported the same measurements of VAS for each of the three activities. Three subjects (subjects 2, 3 and 10) reported that they liked the virtual activity less than any of the two real activities while subject 9 liked the virtual activity more than the two others. Thirteen real group subjects (86%) reported no changes between the R1 and R2 activities. The remaining two subjects (14%) liked the R1 activity more than the R2 activity. Group Virtual 1 made 3 attempts to complete the task in the virtual world activity (VR). One of the attempts was not completed because a mistake was made. In the VR activity, the mean time of the Group Virtual 1 performances was 108 seconds: the best performance was 118 seconds, while the worst performance was 206 seconds. The team improved its performance by 88 seconds (43% better). Regarding the planning time, it ranged between 62 seconds and 184 seconds. The results are different in the real world activity (R1): the number of attempts rose to 13 and the number of errors decreased to zero. The mean of the performances was 26 seconds: the best performance was 18 seconds and the worst was 40 seconds. In R2, Group Virtual 1 made 9 attempts to complete the task and committed one error. The mean of time performance was 23 seconds ranging from 19 seconds for the best time and 31 seconds for the worst time. The shortest planning time was 9 seconds while the longest one was 127 seconds. Table 4 shows details of the performance of all the teams.

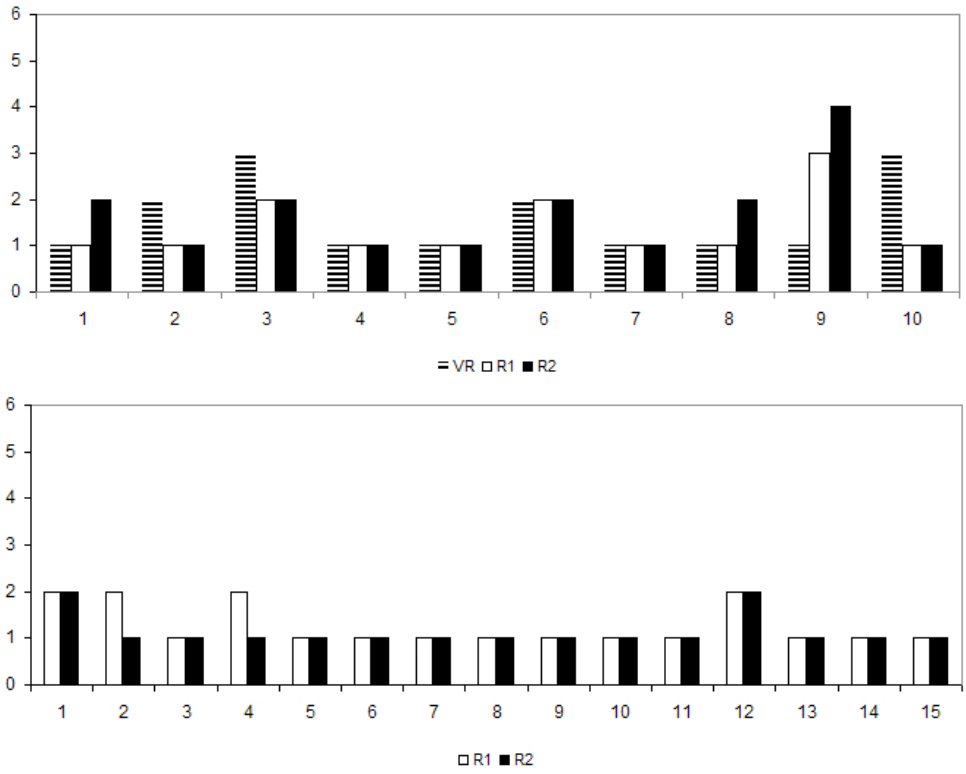

Table 3: Visual Analog Scale (VAS) results for each of the activities for the two groups. In the x-axis are shown the fifteen subjects while the y-axis shows the VAS scale from 1=Delighted to 6=Terrible

				Planning					Performance						
Group	**Experiment**	**Attempts (n.)**	**Errors (n.)**	**Best planning time (sec)**	**Worst planning time (sec)**	**Mean (sec)**	**First Planning time (sec)**	**Last Planning time (sec)**	**Best performance (sec)**	**Worst performance (sec)**	**Mean (sec)**	**Improvement (sec)**	**Improvement (%)**	**First Performance (sec)**	**Last Performance (sec)**
Virtual 1	VR	3	1	62	184	82	184	62	118	206	108	88	43	206	118
Virtual 1	R1	13	0	6	53	18	53	18	18	40	26	20	53	38	18
Virtual 1	R2	9	1	9	127	37	127	9	19	31	23	8	29	29	21
Virtual 2	VR	2	0	95	120	47.5	120	95	120	246	183	126	51	246	120
Virtual 2	R1	11	0	8	44	20	37	8	24	58	33	33	57	58	25
Virtual 2	R2	12	4	6	44	21	44	21	26	41	28	11	27	39	28
Real 1	R1	5	0	19	153	63	153	19	33	131	66	98	75	131	33
Real 1	R2	11	1	15	63	25	63	15	21	42	27	31	74	42	11
Real 2	R1	10	2	4	83	26	53	15	23	88	33	65	74	88	23
Real 2	R2	16	1	8	31	15	31	8	18	34	23	15	43	34	19
Real 3	R1	12	3	6	117	27	117	8	20	36	22	17	46	36	20
Real 3	R2	13	4	7	200	27	200	8	21	30	20	8	28	30	21

Table 4: Summary of results of each experiment (VR, R1 and R2) performed by each team (Virtual 1, Virtual 2, Real 1, Real 2, Real 3)

Table 4 shows the performance and planning results combined for the Virtual and the Real groups for each of the three activities. The virtual group did not make any errors in R1 while the real group averaged 1.67 errors in the same activity. In the second real activity (R2) both the groups made more than 2 errors. The numbers of the attempts were similar for both groups. Table 6 shows the cohesion results by group and experiment. Real group reported very similar values from R1 and R2. Real group showed a high level of task cohesion. However they reported a medium level of social cohesion and a medium level of attraction to the group. Virtual groups reported almost equal value for social cohesion and attraction to the group. However, the task cohesion was higher in the two real activities than in the virtual one.

DISCUSSION

Based on the conclusions from Dexter and Chestnut (1995), we performed an ANOVA test on the VAS results. For R1, the results indicated that there was no difference in reporting VAS from the virtual and the real groups (p-value 0.569). For R2, we obtained a significance of 0.045. We also performed an ANOVA on the Virtual groups to see if there was any difference in VAS reporting among the three activities the group performed and there was no difference (p-value 0.694). The results indicate that in R1, all the subjects reported a similar level of enjoyment despite the fact that the virtual group had played in a simulated environment first. The level of enjoyment decreased in R2. We believe that the subjects got less enjoyment out of the activity because they were tired.

We were not interested in comparing the performance results among the three activities. We are aware that the time needed to complete the activity in the virtual world cannot be compared to the real world. The physical requirements of movement and the distance/speed ratio are not the same in the virtual as in the real world. Also we were not interested in comparing the best performances in R1 and R2. The markers were placed in different locations and for this reason subjects may have needed extra time to complete the activity. However it should be noted that the percentage of improvement in the performance was smaller in R2. This would suggest that in R2 the teams performed closer to the best performance because they already knew what strategy to use.

While the best performances of both groups in R1 and R2 are similar, the improvement from the best and the worst performance in R1 and R2 shows that the virtual group did not improve as much as the real group. This is an indication that the virtual team did perform better

				Planning			Performance				
Group	**Experiment**	**Attempts**	**Errors**	**Shortest plan time**	**Longest plan time**	**Mean**	**Best performance time**	**Worst performance time**	**Mean**	**Improvement**	**Improvement (%)**
Virtual	VR	2.5 ± 0.71	0.5 ± 0.71	78.5 ± 23.83	152 ± 45.25	64.75 ± 24.39	119 ± 1.41	226 ± 28.3	145.5 ± 53.03	107 ± 26.87	47 ± 5.65
Virtual	R1	12 ± 1.41	0	7 ± 1.41	48.50 ± 6.36	19 ± 1.41	21 ± 4.24	49 ± 12.72	29.5 ± 4.94	26.50 ± 9.19	55 ± 2.82
Virtual	R2	10.50 ± 2.12	2.50 ± 2.12	7.50 ± 2.12	85.50 ± 58.69	30 ± 12.72	22.50 ± 4.95	36 ± 7.07	25 ± 3.53	9.50 ± 2.12	28 ± 1.41
Real	R1	9 ± 3.60	1.67 ± 1.52	9.67 ± 8.14	117.67 ± 35.00	38.66 ± 21.07	25.33 ± 6.80	85 ± 47.57	40.33 ± 22.89	60 ± 40.73	65 ± 16.46
Real	R2	13.33 ± 2.51	2 ± 1.73	10 ± 4.35	98 ± 89.77	22.33 ± 6.42	20 ± 1.73	35.33 ± 6.11	23.33 ± 3.51	18 ± 11.79	48.33 ± 23.45

Table 5: Summary of performance and planning results of each experiment (VR, R1 and R2) performed by the Virtual and Real groups

than the real team since its first attempts in R1 and R2. We claim that this is because the virtual group had the opportunity to practice. The virtual group did not spend as much time planning in R1. This is also a clear indication that they had identified strategies in the virtual world and they approached the real situation in the same way.

Both groups made errors in R2. We were not expecting this result because we thought teams would have learned. Mistakes happened because team members jumped on the numbers too soon or they called the wrong number. By the time the teams had to start the second activity, they felt very involved in it and they were running around the room very fast. We believe that the errors made in R2 are not very relevant. However the VR group did not make any errors during R1.

We used ANOVA to study the three dimensions of cohesion among the groups for each of the activities. The real and the virtual group did not show any significant difference between R1 and R2 in any of the seven questions of the cohesion questionnaire. For the virtual group, when comparing the three activities (VR, R1 and R2) we found that only the first question (Our team is united in trying to reach its goals for performance) had a small significant difference (p-value < 0.072). It is interesting to note that the members of the virtual group felt as cohesive in the virtual as in the real activities. This is an encouraging result that shows that team cohesion can be achieved even if the team members are geographically dispersed.

After reviewing the recordings of the virtual world experience we noticed that one of the subjects of Virtual group 2 proposed an interesting strategy. He suggested that each person in the group should pick a set of numbers to run to and jump on. He recommended selecting the numbers alphabetically based on the initial of their first names. For example (names are invented) Ann would have to pick number 1, Bob number 2, Chris number 3, Heather number 4 and Lisa number 5. Then Ann would pick number 6 and so on. Although they soon realized that this strategy was not the most effective, it is interesting to note that the idea of using their names came from the fact that each of the avatars had a nametag on the top of their heads. Subjects did not know each other and such a strategy could not have been used in the real

		Task Cohesion (Mean)			Social Cohesion (Mean)			Individual Attraction to the group (Mean)
Group	**Experiment**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**
Virtual	VR	2.10 ± 1.28	2.00 ± 1.33	6.60 ± 3.06	3.70 ± 2.31	4.90 ± 2.28	4.20 ± 3.15	6.80 ± 2.97
Virtual	R1	1.20 ± 0.63	1.60 ± 1.07	8.10 ± 1.66	3.60 ± 2.71	5.50 ± 2.36	4.20 ± 3.12	6.80 ± 3.22
Virtual	R2	1.30 ± 0.67	1.60 ± 1.07	7.10 ± 2.47	3.80 ± 2.61	4.80 ± 2.34	4.80 ± 3.19	6.70 ± 3.09
Real	R1	2.13 ± 2.80	2.07 ± 2.81	6.53 ± 3.20	3.86 ± 2.07	5.87 ± 3.18	4.00 ± 2.82	3.79 ± 3.35
Real	R2	2.07 ± 2.81	2.07 ± 2.81	6.67 ± 3.45	4.23 ± 2.74	5.27 ± 2.98	4.00 ± 3.29	4.40 ± 3.35

Table 6: cohesion results by groups and experiment

activities. Virtual environments can provide a new and different level of connection between people who do not know each other but who need to work together.

This study has limitations. The sample size is small and it limits the validity of the conclusion. Although it seems to be easy to recruit subjects in a medium size urban college, we experienced problems with commitments and we had to find last minute substitutes in two occasions. Another limitation is related to the time needed to set-up the room for the real activity. We had to clean the room up every time we finished the experiments and we had to set it up again for each new group. Also it was challenging to find five locations where subjects could get online access for the virtual activity during the school year.

In the real world experiment, the thirty markers were randomly placed in a 15x30 foot room. We noticed that each of the groups, after having determined what they believed was best strategy tried to improve their performance times simply by running faster rather than trying new strategies. Future studies should consider using a larger room. We believe that a basketball court sized space would be sufficient. In such a situation team members would not be able to run all the time because they would get tired and, instead they would try different strategies in order to improve their performance.

CONCLUSION

While this experiment was limited in its scope and in the extent of data that could be collected, it was primarily intended to demonstrate the use of a virtual world to conduct experiments such the one described.

There are strong indications of the value of training in a virtual world when real world practice is not an option. It appears that teams that utilize a virtual world to prepare for performance in an actual situation are better prepared than teams who cannot and they perform better not only initially but also during subsequent iterations in real settings. We believe this is due in part to a practice effect, but also from the team building activities (e.g., strategy planning) that the team can conduct in the virtual environment. An example of a distributed team that could benefit from a multi-player, online, virtual environment solution is the Disaster Medical Assistance Team (DMAT). A fully deployed DMAT is comprised of 35 highly qualified physicians, nurses, allied health professionals, pharmacists, laboratory technicians, and communication specialists supported by logistics, administrative, and security staff. Each member of a DMAT is a volunteer. When an emergency occurs, such as natural disasters or terrorist incidents, these

teams are called to respond to the emergencies. Usually the individual personnel are called separately and then put together as a team, with an assigned leader. Since they come from different parts of the country they are not accustomed to working together because they often have never met each other. Moreover, they probably have never been trained as a team.

For a distributed team like DMAT, virtual team training offers a potential training solution (De Leo et al., 2009). We strongly believe that game-based solutions can overcome issues related to the training of geographically dispersed teams. We understand that jumping on markers does not involve the same cognitive and physical skills that real teams have to perform once deployed. More research similar to the research described in this paper is needed to determine: 1) if what is experienced in a virtual world can effectively be transferred to real operations, and 2) if teams formed in a virtual environment express the same level of cohesiveness as teams formed in a real world.

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REFERENCES

Beer, M. (1976). The technology of organization development. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology,* 937-994.

Beer, M. & Walton, A. E. (1987). Organization Change and Development. *Annual Review of Psychology, 38,* 339-367.

Buller, P. F. (1986). The team building–task performance relation: Some conceptual and methodological refinements. *Group and Organization Studies, 11,* 147-168.

Buller, P. F., & Bell, C. H. (1986). Effects of team building and goal setting on productivity: A field experiment. *Academy of Management Journal, 29*, 305-328.

Carless, S. A., & DePaola, C. (2000). The measurement of cohesion in work teams. *Small Group Research, 31(1),* 71-88.

Dale, E., (1969). *Audiovisual methods in teaching*. New York: Holt, Rinehart & Winston.

Dexter F, Chestnut DH. (1995). Analysis of statistical tests to compare visual analog scale measurements among groups. *Anesthesiology*, 82(4):896-902.

De Leo, G., Austin, T., Mastaglio, T. (2009). A game-based approach for training and assessing medical response team. *Annual ISOneWorld Conference Emergent Challenges in IS/IT* .

Dion, K. L., & Evans, C. R. (1992). On cohesiveness: Reply to Keyton and other critics of the construct. *Small Group Research, 23*, 242-250.

Dyer, W.G. (1977). *Team building: Issues and alternatives. Reading.* MA: Addison-Wesley.

Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition & Emotion, 9*, 87–108.

Hogg, M. A. (1992). *The social psychology of group cohesiveness: Attraction to social identity.* New York: Harvester Wheatsheaf.

Huse, E.F. (1980). *Organization development and change* (2nd ed.). St. Paul, MN: West.

Jaffee, E. D., & Nebenzahl, I. D. (1990). Group interaction and business game performance. *Simulation &Gaming, 21(2),* 133-146.

Kaiser, P., Tullar, W., & McKowen, D. (2000). Student Team Projects by Internet. *Business Communication Quarterly*, Vol. 63, No.4, pp. 75-82.

Kayworth, T. & Leidner, D. (2000). The Global Virtual Manager: A Prescription for Success. *European Management Journal,* Vol. 18, No.2, pp. 183-194.

Liedtka, J. M. (1989). Value Congruence: The Interplay of Individual and Organizational Value Systems. *Journal of Business Ethics 8*, 805-815.

Malhotra, A., Majchrzak, A., Carman, R., & Lott, V. (2001). Radical Innovation Without Collocation: A Case Study at Boeing-Rocketdyne. *MIS Quarterly*, Vol. 25, No.2, pp. 229-249.

Majchrzak, A., Rice, R., King, N., Malhotra, A., & Ba, S. (2000a). Computer-mediated Inter-organizational Knowledge-sharing: Insights from a Virtual Team Innovating Using a Collaborative Tool. *Information Resources Management Journal*, Vol. 13, No.1, pp. 44-53.

Majchrzak, A., Rice, R., Malhotra, A., King, N., & Ba, S. (2000b). Technology Adaptation: The Case of a Computer-supported Inter-organizational Virtual Team. *MIS Quarterly*, Vol. 24, No.4, pp. 569-600.

Maznevski, M. & Chudoba, K. (2001). Bridging Space Over Time: Global Virtual Team Dynamics and Effectiveness. *Organization Science*, Vol. 11, No.5, pp. 473-492.

Mullen, B., & Copper, C. (1994). The relation between group cohesiveness and performance: An integration. *Psychological Bulletin,* 115, 210-227.

Pascual, R. G., Mills, M. C., and Blendell, C. (1999). Supporting Distributed and Ad-hoc Team Interaction. *People in control: An International Conference on Human Interfaces in Control Rooms, Cockpits, and Command Centres*, 64-71.

Powell, A., Piccoli, G., & Ives, B. (2004). Virtual Team: A Review of Current Literature and Directions

for Future Research. *The DATA BASE for Advances in Information Systems,* pp. 6-36.
Shandler, M., & Egan, M. (1996). *VROOM! Turbo-charged team building*. New York: American Management Association.
Suchan, J. & Hayzak, G. (2001). The Communication Characteristics of Virtual Teams: A Case Study. *IEEE Transactions on Professional Communication*, Vol. 44, No.3, pp. 174-186.
Widmeyer, W. N., Brawley, L. R., & Carron, A. V. (1985). *The measurement of cohesion in sport teams: The Group Environment Questionnaire*. London, Ontario, Canada: Sports Dynamics.
Wolfe, J., Bowen, D. D.,&Roberts, R. C. (1989). Team-building effects on company performance. *Simulation & Gaming, 20(4),* 388-408.