Online Supplemental Material for:

The effect of a concept mapping intervention on shared cognition and adaptive team performance over time
Simulation

Each decision aspect was associated with a specific amount of costs. For instance, if a large building burned down, this would cost 3000 points, whereas closing roads to reach the incident location would cost 600 points, and entering a burning building with a high risk of collapsing would cost 2000 points. The quality of the teams’ decisions was calculated as the sum of all costs. The team’s decisions were registered in an answer sheet by the fire commander. Each team member received an answer sheet to be aware of the decisions to be made, but it was only the decisions registered on the fire commander’s answer sheet that were used to derive the team’s performance calculations (see Figure 1).

Figure 1

Extract of the Answer Sheet that the Fire Commander must Fill in

| Finished after | minutes |
|----------------|---------|

| Intervention | A1 | A2 | A3 | A4 |
|--------------|----|----|----|----|
| Number of Large Units | 0  | 0  | 0  | 0  |
| Number of Small Units | 0  | 0  | 0  | 0  |
| Unit Inside | | | | |
| Number of Special Units for Evacuation | 0  | 0  | 0  | 0  |

| Closing Routes | Route A | Route B | Route C | Route D |
|----------------|---------|---------|---------|---------|
| Route H | | | | |
| Route I | | | | |
| Route J | | | | |
| Route K | | | | |
Figure 2

Extract of the Task Instruction, Task 1 Information, and Map Given to the Fire Brigade Commander

Instructions for the Fire Brigade Commander

Your goal is to **minimize the fire damage** incurred by the incident, indicated as **damage costs/points**. Fire damage occurs due to **damage** to the buildings caused by the fire. However, it is equally important that you minimize the **danger** to which your own people are exposed. In all occasions, decisions have to be made as quick as possible.

**After reading this you should to be able to:**

1. Calculate how to get the required Extinguishing capacity (EC) to put out the fire
2. Calculate the damage costs to the buildings.
3. Determine whether you should go inside a building or not.

Scenario Alpha

Fire commander

- 20:15
- Wind strength 6 in → Eastern direction

| House | People inside the building |
|-------|---------------------------|
| a1 Fire Intensity: 6 | 0 |
| a2 | 20 |
| a3 | 60 |
| a4 Fire Intensity: 9 | 0 |
Measures

Task Mental Model Operationalization

To calculate task mental model similarity, we used UCINET – a network-analysis program that provides a similarity measure based on Pearson’s correlations (Borgatti et al., 2002) – following the procedure developed by Mathieu et al. (2000). We made a matrix for each team containing the three individuals’ matrices (i.e., the individuals’ evaluation of the pairs of sentences). Next, we used UCINET to calculate the similarity among the ten pairs of sentences of all team members, for each team-level matrix. This similarity index ranged from −1 (complete disagreement) to 1 (complete agreement/sharedness). The ten similarity values were displayed in a matrix. Finally, the task mental model similarity index of each team was calculated based on the average of the ten similarity values.

To calculate task mental model accuracy, we asked three expert-members (the second author who developed the simulation, and the first and fourth authors who ran the experiment) to answer the same task mental model items. We averaged the individual expert-members scores and made a matrix containing the average scores. To calculate the task mental model accuracy for each team, we used a similar procedure to the one we used to calculate similarity. For accuracy, we made a matrix for each team containing four individual matrices (three team members plus a matrix with the average experts’ scores). We used UCINET to calculate the accuracy among the ten pairs of sentences of all team members, for each team-level matrix. This accuracy index ranged from −1 (complete disagreement) to 1 (complete agreement/sharedness). The ten accuracy values were displayed in a matrix and were averaged to calculate the task mental model accuracy of each team.

Transactive Memory System Operationalization

We asked each team member to indicate the self-report of the expertise on the 11 knowledge areas indicated below on a 7-point scale (1 = no expertise at all to 7 = full
expertise). To obtain team members’ reports of colleagues’ expertise, participants were presented the same knowledge areas, and were asked to tag one expert for each area. Participants could tag themselves as the expert on a particular topic.

Eleven knowledge areas:

a) Probability of a building catching fire
b) Environmental cost for extinguishing a fire
c) Knowing buildings structural weaknesses
d) Number of unites needed to extinguish a fire
e) Cost of damage caused to buildings by fire
f) Knowing how safe it is to enter a building
g) Number of people inside the buildings
h) The costs of closing roads
i) The buildings that should be evacuated
j) The probability of a building to collapse
k) Chemicals stored inside buildings

Transactive Memory System Accuracy Operationalization

Transactive memory system accuracy was estimated in three steps. In the first step, the scores of self-reported expertise were linked with the scores of identified experts. Following Austin’s (2003) approach, we created an accuracy measure for each individual and knowledge area. In the second step, individual skill accuracy scores were averaged to create a single individual expertise accuracy score. Finally, in the third step, we averaged the individual expertise accuracy scores to create a team-level score of transactive memory systems accuracy. The individual level measure of transactive memory system accuracy presented acceptable internal consistency, $\alpha = .67$. Individual responses were aggregated to the team level. To justify aggregation, we computed $r_{wg(j)}$ (James et al., 1993) and ICCs.
Online Supplemental Materials for Concept Mapping Intervention

(Bliese, 2000). The values were in accordance with the required criteria: \( r_{wg(j)} = .89 \), ICC(1) = .35, and ICC(2) = .62.

**Results**

**Impact of the Concept Mapping Intervention on Adaptive Team Performance**

**Level 1 Analysis: Describing the Trajectory of Team Performance over Time**

In the first part of the model, we determined the fixed relation between time and team performance. The ICC value for team performance was .03 meaning that 3% of the variance was attributable to between-team differences and 97% of the variance was attributable to within-differences over time. Although the ICC value is not of sufficient magnitude to assume non-independence, we tested a discontinuous growth model with these data. In our sample, the large within-level effect happens because the scores after the change are much lower than before the change in the task. Thus, the difference between sessions is much larger than the difference between teams (Bliese & Ployhart, 2002).

The results of the fixed relation between time and team performance revealed a non-significant slope during the pre-change period, \( \gamma = 30.57, t = 0.09, p = .926 \), and a significant negative transition adaptation effect suggesting that, on average, team performance decreased from the pre-change to the post-change period, \( \gamma = -10722.94, t = -12.27, p < .001 \). The results also revealed a non-significant amount of reacquisition adaptation suggesting that, on average, the slope of team performance was not significant different in the pre-change and in the post-change period, \( \gamma = -24.05, t = -0.05, p = .961 \). Whereas the objective results refer to the average trajectories over all teams, next we investigate variability in growth parameters between teams. The results show that the comparison of the random-intercept model with the baseline model significantly improved the fit of the model, \( \Delta LL = -2.09, p = .041 \). We determined the variability among teams in the rate of change in team performance. Analyses did not provide evidence for a significant amount of random variability in the slope, \( \gamma = \).
30.57, $t = 0.10, p = .921$, provided evidence for a significant amount of variability in the transition adaptation effect, $\gamma = -10711.89, t = -13.38, p < .001$, and did not provide evidence for a significant amount of random variability in the reacquisition adaptation, $\gamma = -13.11, t = -0.03, p = .977$. The comparison of the random-slope model with the random-intercept model improved the fit of the model, $\Delta \text{LL} = -7.75, p = .009$. Thus, the best model accounts for difference in transition adaptation in the pre-change period, as well as for difference in transition adaptation in the post-change period. The results suggest that the model controlling for autocorrelation improved the model fit, $\Delta \text{LL} = -9.13, p < .001$. Thus, we controlled for autocorrelation in the further analysis.

**Impact of the Concept Mapping Intervention on Task Mental Model Similarity and Accuracy**

**Level 1 Analysis: Describing the Trajectory of Task Mental Model Similarity over Time**

First, we analyzed the effect of the concept mapping intervention on task mental model similarity. The ICC value for task mental model similarity was .27, meaning that 27% of the variance was attributable to between-team differences and 73% of the variance was attributable to within-differences over time. The ICC value is of sufficient magnitude to assume non-independence, and to test a discontinuous growth model with these data (Bliese & Ployhart, 2002).

The results of the fixed relation between the slope and task mental model similarity, as well as between transition adaptation and task mental model similarity were non-significant, slope: $-.01, t = -0.65, p = .519$; transition adaptation: $.04, t = 0.64, p = .523$.

These results suggest that on average the teams did not show an increase in task mental model similarity neither in the pre-change period, nor from the pre-change to the post-change period. Next, we determined the variability in the growth parameters. The comparison of the random-intercept model with the baseline model significantly improved the fit of the model,
Δ2LL = −14.18, p < .001. Next, we determined the variability among teams in the rate of change in task mental model similarity. Analyses did not provide evidence for a significant amount of random variability in the slope, $\gamma = -0.01, t = -0.74, p = .462$, and in the transition adaptation effect, $\gamma = 0.05, t = 0.80, p = .427$. The comparison of the random-slope model with the random-intercept model did not improve the fit of the model, Δ2LL = −0.22, p = .801. Thus, the model with a fixed intercept fitted the data better than the model that allows teams to differ in their initial level of task mental model similarity. Finally, the results suggest that the model controlling for autocorrelation did not improve the model fit, Δ2LL = −0.50, p = .318.

**Level 1 Analysis: Describing the Trajectory of Task Mental Model Accuracy over Time**

First, we analyzed the effect of the concept mapping intervention on task mental model accuracy. The ICC value for task mental model accuracy was .43, meaning that 43% of the variance was attributable to between-team differences and 57% of the variance was attributable to within-differences over time. The ICC value is of sufficient magnitude to assume non-independence. The results of the fixed relation between the slope and task mental model accuracy, as well as between transition adaptation and task mental model accuracy were non-significant: slope: −0.01, $t = -0.50, p = .619$; transition adaptation: $0.01, t = 0.09, p = .927$. These results suggest that on average the teams did not show an increase in task mental model accuracy neither in the pre-change period, nor from the pre-change to the post-change period.

Next, we determined the variability in the growth parameters. The comparison of the random-intercept model with the baseline model significantly improved the fit of the model, Δ2LL = −32.37, p < .001. We determined the variability among teams in the rate of change in task mental model accuracy. Analyses did not provide evidence for a significant amount of random variability in the time effect, $\gamma = -.01, t = -0.74, p = .460$, and in the transition adaptation effect, $\gamma = 0.05, t = 0.80, p = .427$. The comparison of the random-slope model with the random-intercept model did not improve the fit of the model, Δ2LL = −0.22, p = .801. Thus, the model with a fixed intercept fitted the data better than the model that allows teams to differ in their initial level of task mental model similarity. Finally, the results suggest that the model controlling for autocorrelation did not improve the model fit, Δ2LL = −0.50, p = .318.
adaptation effect, $\gamma = .02, t = 0.23, p = .815$. The comparison of the random-slope model with the random-intercept model did not improve the fit of the model, $\Delta2LL= -1.65, p = .192$.

Thus, the model with a fixed intercept fitted the data better than the model that allows teams to differ in their initial level of task mental model accuracy. Finally, the results suggest that the model controlling for autocorrelation did not improve the model fit, $\Delta2LL= -0.13, p = .604$.

**References**

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions* (pp. 349–381). Jossey-Bass.

Bliese, P. D., & Ployhart, R. E. (2002). Growth modeling using random coefficient models: Model building, testing, and illustrations. *Organizational Research Methods, 5*(4), 362–387. https://doi.org/10.1177/109442802237116

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for Windows: Software for social network analysis*. Analytic Technologies.

James, L. R., Demaree, R. J., & Wolf, G. (1993). $r_{wg}$: An assessment of within group interrater agreement. *Journal of Applied Psychology, 78*(2), 306–309. https://doi.org/10.1037/0021-9010.78.2.306