# COLLABORATIVE DEVELOPMENT OF EXPERTISE: EVALUATION OF AN ON-THE-JOB (OJT) TRAINING PROGRAM

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The Collaborative Development of Expertise (CDE) program was created to support transfer of knowledge and skill from experienced personnel to trainees in on-the-job settings. Thirty-six active-duty Naval Air Defense Coordinators (ADCs) were recruited from Combat Information Centers on board AEGIS-class cruisers. The experimental group received a workshop, practice, and coaching in the CDE program. The control group did not learn CDE during the evaluation, relying upon current Naval training practices. Measures were developed to evaluate how CDE impacted mission debriefs between a trainer and trainee, and trainee on-the-job performance. Analysis of mission debriefs showed that CDE trainers and trainees discussed more of the cognitive challenges associated with the ADC position, and used more expert training and learning strategies than did control group participants. Expert ADCs, blind to experimental condition, rated CDE trainee performance as higher than the control group. Limitations of the study and future development objectives for CDE are offered.

## INTRODUCTION

This paper summarizes an experimental evaluation of the Collaborative Development of Expertise (CDE) program for a specific U.S. Navy position. CDE was developed to help experienced workers pass on their expertise to less-experienced workers. It was developed based on models of expertise and our earlier research on OJT (Crandall, Kyne, Militello, & Klein, 1992; Crandall, Pliske, & Zsambok, 1998; Pliske, Green, Crandall & Zsambok, 2000; and Zsambok, Kaempf, Crandall, & Kyne, 1996). The CDE program views trainers and trainees as partners in the learning process. It is used in the context of a scenario-based training exercise and involves a trainer/trainee dyad completing a series of six steps (see Table 1).

The CDE program provides trainers and trainees with job aids to help them collaborate in the assessment and correction of the trainee's performance. We developed these job aids using two conceptual frameworks.

The cognitive challenges framework focuses trainers' and trainees' attention on the most challenging aspects of the job to be trained. We used Cognitive Task Analysis to identify the cognitive challenges associated with the position of Naval Air Defense Coordinators (ADCs) in the Combat Information Center (CIC) on AEGIS-class cruisers. The eight ADC challenges include: Building and Maintaining Situation Awareness, Validating Identity, Prioritizing/Data Filtering, Managing Air Space, Gather Information, Systems Operation, Evaluating and Disseminating Information, Proper Communications and Phraseology. Cognitive challenges are used during the goal-setting process of the pre-brief step, and also to assess trainee performance during the training exercise. Trainers use a recording form called the Observation and Assessment Record (OAR) to evaluate trainee performance on the cognitive challenges during the training scenario. Trainees use the Trainee Debrief Worksheet (TDW) to self-assess their performance on the cognitive challenges.

The second framework is a set of training and learning strategies used by the trainer and trainee respectively to diagnose and discuss trainee performance issues. These strategies were previously identified through a study of expert trainers in a wide variety of military and civilian domains (Crandall et al., 1992; Zsambok et al., 1996). Sixteen of these strategies were adapted for use by ADC trainers to assist them in sharing cognitive and behavioral expertise. Nine training strategies were also adapted for use by ADC trainees as "learning" strategies. Learning strategies effectively mirror the training strategies, assisting the trainee in actively querying the trainer about his/her job knowledge, thinking patterns, and hands-on skills. The strategy list and details surrounding their development can be found in Pliske et al. (2000).

Table 1

*Description of Trainer and Trainee Responsibilities in each of the Six Steps of the CDE Process.*

| CDE Step | Trainer Responsibilities | Trainee Responsibilities |
|---|---|---|
| 1. Pre-brief | • Identify training goals | • Identify learning goals with trainer |
| 2. Training Exercise | • Take notes on trainee's performance using OAR<br>• Determine where trainee needs help<br>• Select and implement training strategies | • Perform training exercise |
| 3. One-on-one Debrief Preparation | • Encourage the trainee to self-assess using TDW<br>• Add additional comments to OAR<br>• Select debriefing strategies | • Fill out TDW<br>• Identify key problem areas |
| 4. One-on-one Debrief | • Review TDW<br>• Implement debriefing strategies<br>• Discuss TDW and OAR<br>• Help trainee complete TDW "Strategies for Improvement" | • Use learning strategies to obtain feedback from instructor<br>• Discuss TDW with trainer |
| 5. Team Debrief* | • Meet with other trainers to discuss team performance issues<br>• Discuss team performance issues with trainees | • Receive feedback on team performance |
| 6. One-on-one Follow Through* | • Discuss any additional issues that surfaced during team debrief<br>• Recommend off-line learning strategies | • Discuss any additional issues that surfaced during team debrief |
| *optional steps (not evaluated in this study) | | |

A formal evaluation of the CDE was conducted for Steps 1-4 only, using active ADC personnel assigned to either a CDE or control group. We developed hypotheses in three performance areas:

1) Job Related Focus

CDE trainers will discuss a greater number of job-relevant topics in the debrief compared to control group trainers. CDE trainers will also discuss a greater number of cognitive challenges during the debrief.

2) Training and Learning Strategies

CDE trainers will use the instructed training strategies more often than the control group. Likewise, CDE trainees will use a greater number of the learning strategies.

3) Trainee Performance

CDE trainees will demonstrate better scenario performance regarding cognitive challenges, compared with control-group trainees.

## METHOD

### Participants

Thirty-six ADCs from the Pacific Naval Fleet served as subjects. All were male. Eighteen qualified ADCs with less than three years experience served as trainees. The other eighteen participants served as trainers, with an average time in service of 168 months. One-half of the trainers and trainees were assigned to the CDE condition.

### Apparatus

ADC trainees were trained individually on a low-fidelity, simulated exercise. Five 486-class computers were used operating at 50 MHz with MS Windows 3.1 and 15-inch VGA monitors. All were equipped with the GT-ASP (Georgia Tech Aegis Simulation Platform). The GT-ASP contains scenarios that follow the course of one ship that travels through the Straits of Hormuz, into the Arabian Gulf, proceeding north. The computer screen resembles the ADC screen in the CIC in terms of the appearance and movement of tracks.

### Procedure

*Experimental Group.* Trainers assigned to the CDE group participated in a one day train-the-trainer workshop that lasted approximately eight hours. The workshop provided an introduction to the CDE steps, ADC cognitive challenges, and training aids (OAR, CDE training strategies). Trainers were trained and tested on use of the GT-ASP. Trainers were then given opportunities to role-play as trainers during cycles of pre-brief, GT-ASP training exercise, and debrief.

CDE trainees received an abbreviated version (45 minutes) of the trainer workshop that focused on understanding the cognitive challenges, active use of learning strategies and TDW, and GT-ASP training.

CDE trainers were scheduled for data collection within six days of their workshop. Trainees participated in data collection the same day as their workshop. Trainer-trainee dyads were run through four consecutive training cycles of the four CDE steps (pre-brief, scenario, debrief preparation, debrief). The first three cycles were opportunities for the dyads to practice CDE steps, and for the trainee to improve in scenario performance. The third scenario debrief was used to code trainer discussion of cognitive challenges and to count the number of job-relevant topics discussed. The fourth exercise scenario was used to evaluate trainee performance, and was not followed by a debrief.

*Control Group.* Trainers and trainees were instructed on the GT-ASP during the same day, and were not provided any other training. Control group data collection sessions were executed the same as the experimental group. The same exercise scenarios were presented in the same order as in CDE condition.

### Ratings

A single rater, blind to experimental condition, performed ratings on learning and training strategy use using a typed transcript of the third scenario debrief. A qualified ADC trainer, blind to experimental condition used the transcript to rate the number of job-relevant topics that were covered in the third debrief, and also which cognitive challenges were discussed. Trainee performance was assessed based on the fourth exercise scenario. Two qualified ADCs watched videotape replays of trainee performance and independently rated trainee performance in terms of the cognitive challenges, plus an overall rating, then discussed their ratings and produced a third consensus rating set that was used for analysis.

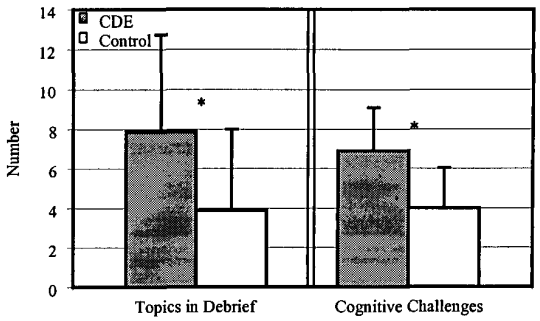
## RESULTS

Results are organized based on experimental hypotheses. One-way t-tests assuming equal variance were used to assess between-group differences.

### Trainer Discussion of Job Related Content Issues

*Topics.* Figure 1 shows that the CDE group covered twice as many job-related topics during the debrief, compared with the control group. An examination of the transcripts showed that nearly all topics were initiated by the trainer.

*Cognitive Challenges.* Figure 1 shows that on average, the CDE group trainer and trainees meaningfully discussed a greater number of cognitive challenges than did the control group dyads.




"*" indicates significant between-group differences to $p < .05$.

*Figure 1.* Trainer performance in discussing job-relevant content

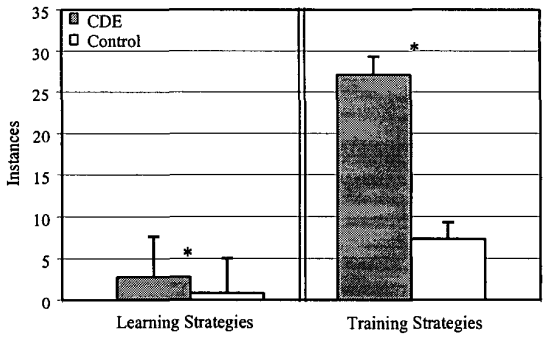
### Learning & Training Strategies

*Training Instances.* Figure 2 shows the average number of instances that trainers used any training strategy. CDE trainers used the training strategies nearly four times as often as the control group trainers.

*Learning Instances.* Figure 2 shows the average number of instances that a trainee used any learning strategy. CDE trainees employed the learning strategies three times as often as the control group trainees. However, CDE trainee participation was still rather low.

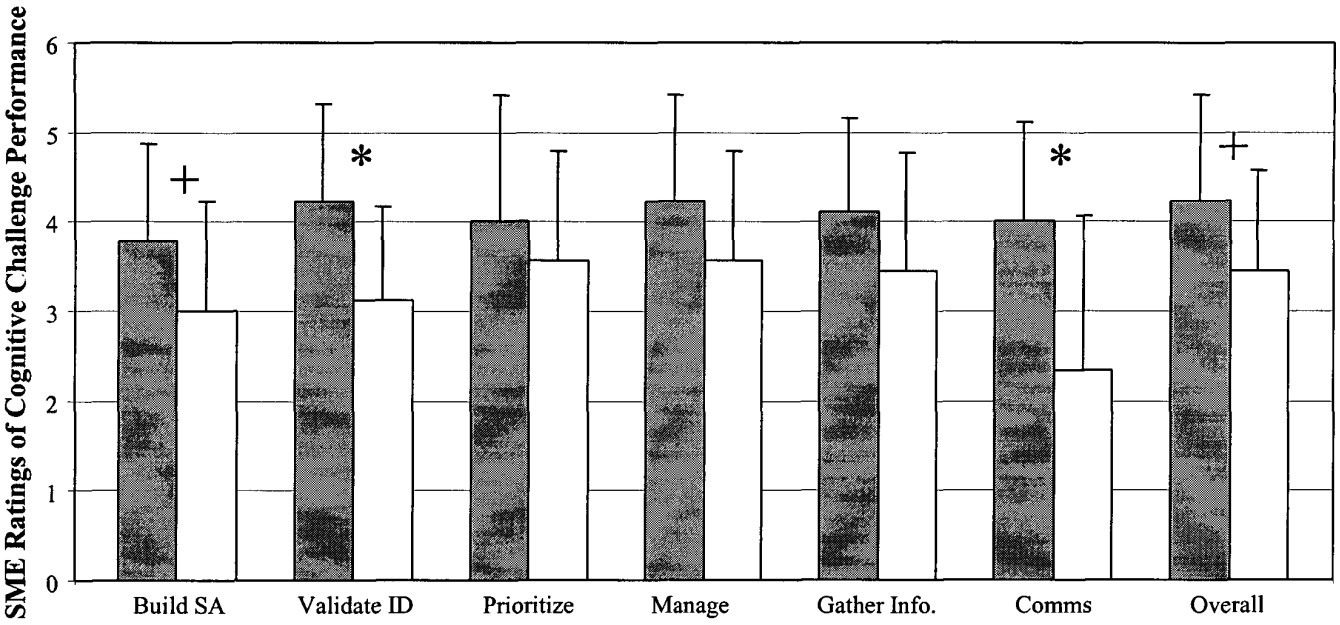
### Trainee Performance

Two of the eight cognitive challenges (disseminating information) were not included in analyses because of low interrater reliability. Figure 3 shows that the CDE group attained significantly higher ratings on two of the remaining rating categories (rating 1=low, 6=high). There were marginally significant differences favoring the CDE group for two other performance rating categories. The CDE group showed higher mean ratings on the remaining challenges, but the differences were not significant.




"*" indicates significant between-group differences to $p < .01$.

*Figure 2.* Use of learning and training strategies by dyads




"*" indicates a significant between-group difference to p< .05.
"+" indicates a marginally significant difference to p< .10.
*Figure 3.* Cognitive challenge performance ratings

## DISCUSSION

The CDE program was developed to improve experienced workers' ability to pass their expertise onto less-experienced workers within existing training cycles. It provides trainers and trainees with job aids and recording forms to help them collaboratively assess, strengthen, and correct the trainee's performance. The CDE program was evaluated by comparing the performance of trainer/trainee dyads who participated in the CDE program to the performance of a control group of trainer/trainee dyads.

An important part of CDE is the use of CTA to develop a list of cognitive challenges for the specific job to be trained (the ADC position for this project), so that trainers can be prompted to share higher-level knowledge such as their thinking, judgments, and anticipations. We predicted that CDE trainers would focus more on discussions of cognitive challenges, and more generally on job-related topics than would control group trainers. In confirmation, ratings of debrief transcripts by an expert ADC showed that CDE dyads discussed twice as many job-related topics during the debrief as compared to control dyads and that, on average, CDE trainers discussed almost twice as many of the job's cognitive challenges.

The CDE program also asserts that optimal learning occurs when the trainer and trainee collaboratively establish shared learning objectives. The workshop teaches trainees how to use learning strategies to elicit additional information from their trainers. As predicted, the CDE trainees used a greater number of these strategies, nearly three times as many.

They asked questions, shared observations, and engaged in more dialogue with their trainer/coach. However, they could have used these strategies more than they did, suggesting that the trainee workshop could be improved (remember it lasted only 45 minutes). The CDE program also provides strategies to trainers that promote tailoring of feedback to the trainee's specific needs. As predicted, CDE trainers used these strategies more often than control trainers (27 vs. 7 instances).

The goal of the CDE program is to improve one-on-one training so that trainees will learn how to perform their job better. The data from the evaluation study provided marginal support for the third hypothesis that CDE dyads would show more greatly improved performance in the test scenario. ADCs (blind to experimental condition) rated the cognitively challenging performance areas of trainees during the test scenario. Trainees in the CDE dyads consistently received higher performance ratings from SMEs than control trainees on the individual cognitive challenges. Two of six challenges resulted in significantly higher ratings, and an additional two rating categories received marginally significant differences favoring CDE dyads.

Our post-test study design limited results, with measures only administered once. An improved design would establish a baseline on most or all of the measures, with a second administration of measures after the training

intervention. We also had difficulty recruiting active-duty shipboard personnel. In view of the small sample size and post-test only study design, it is compelling that we found many between-group differences.

The GT-ASP environment was chosen because it runs on relatively simple equipment that is easily transported. But the use of GT-ASP only allowed us to assess the performance of individual trainees. Normally, the ADC performs his/her task as part of the CIC team, but we were unable to assess ADC teamwork. Since CDE Steps 5 and 6 were not evaluated in this study, a team training simulation environment would provide the opportunity to evaluate the aspects of the CDE program that promote teamwork.

## ACKNOWLEDGEMENT

This research effort was sponsored by the Naval Air Warfare Center Training Systems Division Contract N61339-98-C-0026.

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