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# The role of interpersonal factors in the application of computer-based training in an industrial setting

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**Abstract:** This study measures the impact of training content validity, opportunity to use learning, and four interpersonal support factors on supervisory ratings of workplace application of standard operating procedures learned from computer-based training. After controlling for learning and motivation to transfer, a hierarchical regression analysis showed that content validity, supervisor support variables (supervisor sanctions, supervisor support) and co-worker support variables (peer support, change resistance) produced significant increments in explained variance in performance ratings. In the full regression model, content validity, peer support, change resistance and supervisor sanctions emerged as significant predictors of performance ratings ($R^2$ = .43). The findings underscore the value of establishing valid training content and cultivating supervisor and co-worker support for the transfer of workplace learning.

**Keywords:** learning transfer, interpersonal support, training content, supervisor support, peer support

## Perceived factors affecting transfer of computer-based training in an industrial setting

Training will do little to increase performance or meet organizational goals unless what is learned is transferred into on-the-job performance. Unfortunately, research has documented that large numbers of employees do not apply learned knowledge, skills and abilities (KSAs) when they return to the workplace (Baldwin and Ford 1988; Noe 1986). Such findings indicate that absence of learning transfer is a major factor undermining training effectiveness.

Although there are multiple definitions of transfer of learning, it is generally agreed that transfer involves the application, generalizability and maintenance of new knowledge and skills (Ford and Weissbein 1997). Since Baldwin and Ford (1988), researchers have viewed transfer as being affected by a system of influences. In their model, it is seen as a function of three sets of factors: trainee characteristics, training design and the work environment (Baldwin and Ford 1988). Some research has been done on design factors (Noe and Schmitt 1986) but significantly less has been done to understand how work-context factors influence transfer of training (Tannenbaum and Yukl 1992). This study attempts to expand our understanding of the role of these and other factors by examining the power of content validity, opportunity to use, interpersonal support factors to predict learning transfer.

Interpersonal support refers to the behaviour and attitudes of supervisors, managers and co-workers that either support or inhibit learning transfer in the workplace. This support is considered by many authors to be the key to the utilization of workplace learning (Brinkeroff and Montesino 1995; Noe and Schmitt 1986; Rouiller and Goldstein 1993). For example, over forty years ago, Mosel (1957) argued that one of the foremost deterrents to the application of workplace learning was lack of interpersonal support. More recently, Pea (1987) has argued that perception of support for learning transfer from supervisors and co-workers helps create a 'culture of transfer' essential to linking individual changes from training with changes in the organizational system. The implication is that effort and success in the application of workplace learning will be greater in environments characterized by high levels of supervisor and co-worker support.

Although the proposition that interpersonal support plays a strong role in training transfer has a great deal of intuitive appeal, the current research offers mixed results about its value and role in training transfer. For example, several studies have provided evidence that this kind of support is a significant factor in the transfer of workplace learning (e.g., Becker and Klimoski 1989; Brinkerhoff and Montesino 1995; Clark *et al.* 1993; Huczynski and Lewis 1980; Xiao 1996) whereas others have provided contradictory evidence (e.g., Gielen and Vanderklink 1995; Hastings 1994; Russell *et al.* 1985). These results indicate that research is not unanimous in its endorsement of supervisory support as a critical variable in learning transfer.

In addition, research to date has generally said little about the role of co-worker support. Researchers appear to have overlooked the possibility that there may be work situations in which co-worker support is equally or more important than that provided by supervisors. For example, co-worker support could be expected to be more valued by trainees in team-oriented work settings or settings in which characteristics of the job give rise to strong work-group bonds. The latter is often evident in dangerous or hazardous jobs in which individuals depend heavily on their co-workers for reasons of health or safety. In these situations, the power of the work group to influence work

behaviour is significant and could be expected to affect work behaviours, including learning transfer.

The lack of uniform results for the role of supervisor support and the general absence of research addressing co-worker support indicates that more research is needed to understand the dynamics under which these variables operate in learning transfer. The first purpose of this study is therefore to extend our understanding of the respective contributions that supervisor and co-worker support variables can make to learning transfer.

Another limitation of previous transfer research has been the failure to examine how supervisor and co-worker support variables work together with other transfer-related variables. For example, several researchers have suggested that the extent to which individuals are given opportunities to use new learning on the job can influence transfer (Baldwin and Ford 1988; Goldstein 1986; Wexley and Latham 1991). The importance of opportunity to use as a transfer-related factor is based on the notion that individuals who obtain opportunities to use new learning on the job will ultimately be more successful in transferring that learning. Research has demonstrated there are systematic differences in trainees' opportunities to perform trained tasks on the job and that work context and individual characteristics were related to these differences (Ford *et al.* 1992). In general, however, most studies evaluating learning transfer have made the untested assumption that trainees have relatively similar opportunities to practise and perform learned tasks on the job (Ford *et al.* 1992). Very little research has addressed this variable and even less has examined the link between supervisory or co-worker support and the provision of opportunities to use new learning. It is expected, for example, that under high levels of supervisor and co-worker support, opportunity to use would be linked to the prediction of learning transfer. The second purpose of this research is to examine the explanatory power of opportunity to use as a predictor of learning transfer.

The final purpose of this study is to examine the role of perceptions of training content validity in predicting learning transfer. Perceived content validity refers to the extent to which trainees judge the content of training to reflect job requirements accurately. Several authors have suggested the issue of content validity is critical to learning transfer (Ameel 1992; Annette and Sparrow 1985; Baldwin and Ford 1988; Garavaglia 1993), but only limited research has been done to verify this assertion. Huczynski and Lewis (1980) found that two of the three factors that distinguished trainees who attempted transfer from those who did not were (a) a belief that the training would be useful on the job and (b) a belief in the relevance of the course content. Results of other studies have shown that training-related motivation is positively related to trainees' belief that training is appropriate, that it will lead to improved job performance, or that it will enhance career advancement opportunities (Clark *et al.* 1993; Hicks and Klimoski 1987; Seyler *et al.* 1998). Salomon and Perkins (1989) reviewed a number of studies in which learning

transfer did not occur and suggested that the relevance of instructional content is an important and necessary component of transfer.

Despite the common-sense notion that the content validity of training is of critical importance, most training research appears tacitly to assume the job relevance of training content (Baldwin and Magjuka 1991; Baldwin and Ford 1988; Laker 1990). This is a dangerous assumption given the research indicating that thorough, systematic needs assessments prior to training are typically *not* conducted (Saari *et al.* 1988).

In summary, this research investigates the role of supervisor and co-worker support factors, opportunity to use, and content validity in the transfer of learning from computer-based training. The following research hypotheses were examined:

*Hypothesis one:* After controlling for learning and motivation, content validity will explain a significant proportion of the variance in performance ratings.

*Hypothesis two:* After controlling for learning and motivation, supervisor support and supervisor sanctions will explain a significant proportion of variance after accounting for that explained by content validity.

*Hypothesis three:* After controlling for learning and motivation, peer support and change resistance will explain a significant proportion of variance after accounting for that explained by content validity, supervisory support and supervisor sanctions.

*Hypothesis four:* After controlling for learning and motivation, opportunity to use will explain a significant proportion of variance after accounting for that explained by content validity, supervisory and co-worker support variables.

## Method

This cross-sectional study was part of a more extensive study undertaken to evaluate a large-scale computer-based training (CBT) project, the Computer-Aided Training System (CATS) project. The goal of the CATS project was the development and implementation of a CBT system to meet Occupational Safety and Health Administration (OSHA) mandated short- and long-term training requirements and to meet the training information management needs of a 'Fortune 500' size petrochemical producer in the southern United States. This study extends previous work (Seyler *et al.* 1998) examining factors affecting motivation to transfer by focusing on performance as the criterion.

## Sample

Subjects in this study were seventy-three production operators in two continuous production departments manufacturing highly hazardous chemical products. Production operators were responsible for monitoring, operating and maintaining production-related equipment such as reactors, filters, grinders, process analysers, piping, valves, pressure gauges, flow meters and a computerized process control board.

Operators were required to undergo training and certification on thirty to 150 training modules (depending on their job responsibilities) to meet organization and federal certification mandates. Supervisors were also required to be certified on all procedures undertaken by their subordinates. Training consisted of reading and studying computer-based training modules that addressed the knowledge and skills needed to perform standard operating procedures (SOPs) within a specific production unit. The modules were largely text-based presentations of material that included some graphics and occasionally video and sound. Employees accessed and completed the training modules from computer terminals in their work units during down times while doing shift work. Operators and supervisors were able to study modules and take individual exams as often as necessary to reach the 80 per cent test score required by the organization.

Following the successful completion of all required training modules, the instruments used in this study were administered.

## Measures of independent variables

### *Learning*

Learning was measured by employee test scores on computer-based exams. The exams, developed by subject matter experts in the plant, measured the extent to which SOPs had been learned. Scores on the exams were measured as percentage correct. In order to isolate the effect of other variables on the outcome measure, learning was treated as a control variable in this study.

The other independent variables in this study were derived through common factor analysis of two questionnaire instruments compiled or developed by the researchers. Each instrument used five-point Likert-type scales with values ranging from 1 (strongly disagree) to 5 (strongly agree). The factor analysis was conducted on larger samples of workers from the same organization. The instruments and sample sizes included (a) Transfer Climate instrument (sixty-six items), n = 189, item-to-respondent ratio of 2.86:1; and (b) Reaction to Training Questionnaire (twenty-one items), n = 142, item-to-respondent ratio of 6.76:1.

Although the item-to-respondent ratio was lower than desired for the transfer climate instrument, Kaiser's measure of sampling adequacy (MSA)

was .891, indicating a suitable sample for factoring (Hair *et al.* 1998). All individual items also had adequate MSA values. In addition, several factor analysis researchers now suggest that item-to-respondent ratios as low as three to one are acceptable based on simulations and other research (Gorsuch 1997; Guadagnoli and Velicer 1988). For these reasons, the results were considered acceptable.

Common factor analysis was used to identify the latent construct structure. It is considered more appropriate than principal component analysis when the objective is identification of latent structures (Nunnally and Bernstein 1994) and more accurate than principal components analysis for identifying latent constructs, particularly when there are relatively few factors and moderate loadings (Snook and Gorsuch 1989). Oblique rotation was employed because of its suitability for latent variable investigation when latent variables may or may not be orthogonal (Hair *et al.* 1998). The initial criterion used to determine the number of factors to retain was an eigenvalue greater than or equal to one. (For a detailed description of the scale-development procedures and factor analytic techniques see Holton *et al.* 1996).

### *Motivation to transfer*

Seven items ($\alpha$ = .89) measured participants' motivation to transfer. This measure was included in the Reaction to Training questionnaire. Items typical of the scale included 'I plan to use what I learned on the job' and 'I believe the training will help me do my job better'. Similar to the learning measure, motivation to transfer was treated as a control variable because our primary research interest was in isolating the influence of supervisor and co-worker support factors, content validity and opportunity to use on learning transfer in the workplace.

The remaining scales in this study were derived from the transfer climate instrument as previously reported (Holton *et al.* 1997). Rouiller and Goldstein's (1993) original sixty-three-item transfer climate questionnaire was used as a prototype for developing an instrument to measure individual perceptions of transfer climate. This instrument was modified to some degree both to better fit the organization involved in this study and to add to the constructs measured. Modification included (a) deletion of fourteen items that were not appropriate for this organization; (b) addition of ten items constructed to strengthen certain scales or to replace deleted items with ones more appropriate for this organization; and (c) addition of seven items, constructed to represent an opportunity-to-use construct that was not included in Rouiller and Goldstein's (1993) instrument. These changes resulted in the testing of a sixty-six-item instrument.

Factor analysis of this instrument led to the identification of nine factors. Eight of the nine factors exceeded Nunnally and Bernstein's (1994) suggested minimum reliability of .70 for scales in early stages of development. Reliability

estimates ranged from .68 to .95 with an average alpha of .79. The following scales were used in this study.

*Supervisor support* (twenty-three items, $\alpha$ = .95) referred to the extent supervisors reinforce and support use of learning on the job. Example items included 'My advisor meets with me to discuss ways to apply training on the job' and 'My supervisor meets regularly with me to work on problems I may be having in trying to use my training'.

*Supervisor sanctions* (six items, $\alpha$ = .74) referred to responses made by supervisors which oppose or discourage the use of training on the job. Examples included 'My advisor opposes the use of the techniques learned in training that I bring to the unit' and 'My advisor thinks I am being ineffective when I use the techniques taught in training'.

*Peer support* (seven items, $\alpha$ = .83) measured level of peer support and reinforcement for the use of learning on the job. Examples included 'My colleagues encourage me to use the skills I learned in training' and 'My colleagues and I discuss how to apply our training on the job'.

*Change resistance* (five items, $\alpha$ = .69) addressed the degree to which prevailing work-group norms are perceived by the trainee to resist or discourage using new skills. Items included 'More experienced colleagues ridicule me when I use the techniques I learned in training' and 'The skills taught in training do not fit the "image" of my workgroup'.

*Opportunity to use* (seven items, $\alpha$ = .86) referred to the extent trainees are provided with or obtain resources and tasks on the job enabling them to use the skills taught in training. Example items included 'Training aids are available on the job to support what I learned in training' and 'Equipment is available in this unit that allows me to use skills I gained in training'.

*Content validity* Three items ($\alpha$ = .74) were used to measure the degree to which trainees judge the content of training accurately to match job requirement. Items included 'Skills and knowledge taught in the training are the same skills and knowledge needed to do a good job' and 'The standard operating procedures taught in training are correct'.

## Measure of dependent variable

An additional shortcoming of many workplace learning transfer studies has been their nearly singular use of self-reports as outcome measures (Baldwin and Ford 1988; Ford and Weissbein 1997). A number of problems with self-report measures, including leniency (Harris and Schaubroeck 1988) and failure to converge with supervisor ratings (Kraiger 1986), suggest these measures may be 'fatally flawed' as accurate measures of performance (Cardy and Dobbins 1994). In an updated review of transfer research, Ford and Weissbein (1997) reported limited progress in this area, but found just eight transfer studies in the last ten years with criterion measures other than self-report. Moreover, only three of these eight studies included measures of

perceptions of transfer climate or work context, with the rest focusing on various dimensions of the learning process. The criterion problem thus remains a significant issue in learning transfer research.

In this study, a detailed seven-step criterion development and measurement process was used. This process ensured that the performance measures, based on supervisory ratings, assessed a subset of the knowledge, skills and behaviours trainees were expected to transfer from training to the job. The criterion development process was guided by several principles. First, it was critical to link the job behaviours being rated explicitly to what was presented and learned in training. Second, it was necessary to identify and use information related to the performance of highly critical procedures taught in training because these procedures had the highest utility to the organization. Third, it was assumed that supervisors would be able to provide the most accurate ratings on procedures they most frequently observed subordinates performing.

The criterion development and measurement process employed three different instruments (instruments one, two and three). The resulting dependent measures assessed operator performance of SOPs that were performed regularly; critical to quantity, quality or safety of production; and observed frequently by supervisors. The seven-step criterion development process included:

### *1 Procedure identification*

A list of SOPs in the training programme was collected for each production unit participating in the study. The SOPs were (a) specific to each production unit, (b) developed by subject matter experts (SMEs) for inclusion in the CBT, and (c) drawn directly from the CBT modules the operators had completed.

### *2 Identification of selection criteria*

Five SMEs were interviewed to determine the proper criteria for selecting SOPs on which performance could be measured. Three selection criteria were identified: (a) the procedure was tied to an observable behaviour; (b) the procedure was performed either every twelve-hour shift, every three-day shift cycle or at least once a month; and (c) the procedure was critical to unit performance in terms of safety, quality and production rates.

### *3 Identification of critical procedures*

Instrument one asked supervisors to review the list of procedures from step one and identify the most critical procedures, specify which *criteria* (safety, quality and productivity) made the procedure critical, and estimate how frequently the procedure was *performed*. The resulting lists were cross-checked

and validated by SMEs. A subset of approximately fifty procedures for each of the five units was selected based on the results.

### *4 Frequency rating*

Instrument two assessed the relative frequency with which supervisors were able to directly *observe* operator performance of each procedure identified in step three. Each of these procedures was rated by the appropriate supervisor on a five-point Likert scale ranging from 0 (none of the time), 1 (about 25 per cent of the time), 2 (about 50 per cent of the time), 3 (about 75 per cent of the time) to 4 (100 per cent of the time).

### *5 Final list of critical procedures*

The most frequently observed critical SOPs were determined by ranking the mean ratings of the frequency of observation (step four) for each procedure. The twenty SOPs in each unit with the highest mean ratings of observation frequency were chosen as the procedures for which performance ratings were collected.

### *6 Development of the performance-rating instrument*

Instrument three was developed to obtain supervisors' judgements of the percentage of time that operators performed each procedure identified in step five correctly. Correct performance was defined as accurately completing all required steps in the appropriate order as identified in the training programme. This instrument consisted of a five-point Likert-type scale ranging from 0 (none of the time), 1 (about 25 per cent of the time), 2 (about 50 per cent of the time), 3 (about 75 per cent of the time) to 4 (100 per cent of the time). As a check for the raters, written copies of the procedures being rated were attached to the rating instrument.

### *7 Performance rating*

Supervisors were given ten days to rate each subordinate using instrument three. One of the researchers met with each supervisor to review both the procedures and rating process. A call was made to each supervisor during the rating period to discuss the rating process and answer questions.

## Data analysis

Hierarchical regression analysis was used to examine how variance in performance ratings was partitioned among predictors and to test predictions made about the ability of the independent variables to explain variance in the

criterion measure. Hierarchical regression provides a measure of the amount of variance explained and an indication of the practical significance of an effect, which can be important in early phases of model development (Cohen and Cohen 1983; Mook 1983). To test the hypotheses, the order of entry of variables was determined by the logical sequence in which the variables appeared in the training transfer situation. After entering learning and motivation as control variables, content validity was entered second because trainee assessment of training validity was among the first judgements made upon entry into training. Supervisor support and supervisor sanctions were entered second because these would be among the first factors trainees encountered as they re-entered work to initiate transfer. Peer support and change resistance were entered third to determine how much variance these variables accounted for over and above that explained by the supervisor support variables. Opportunity to use was entered last because this factor was presumed to follow from levels of supervisor and co-worker support.

## Results

Analysis to establish suitability of the data for regression analysis indicated no serious violations of the basic assumptions of multiple regression analysis and no multicolinearity among the predictor variables. Diagnosis for influential observations, which can undermine maximum predictive accuracy in regression analysis (Hair *et al.* 1998), led to the deletion of three observations (Bates *et al.* in press). This, together with the listwise deletion of missing values, reduced the final sample size to sixty-five. We had planned to obtain a larger sample, but unexpected events at the company forced the project to terminate early. Although a sample of sixty-five is lower than desired, the respondent-to-variable ratio of 8.1 to one still exceeds generally accepted guidelines specifying a minimum ratio of five to one (Hair *et al.* 1998). Means, standard deviations, reliability estimates, correlations for all variables are shown in Table 1.

Results from each regression model (see Table 2) indicated:

### *Hypothesis one*

The control variables, learning and motivation to transfer, did not account for a significant proportion of the variance in performance ratings ($R^2 = .02$, $F_{(2,63)} = .57$). The addition of content validity to the model increased explained variance in performance by .03, a non-significant increase ($p = .14$). The model with learning, motivation and content validity was not significant ($R^2 = .05$, $F_{(3,62)} = 1.12$).

**Table 1** Means, standard deviations, reliability estimates and one-tailed correlations

| | $\alpha$ | *Mean* | *Std. Deviation* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Performance | – | 3.33 | .46 | – | | | | | | | | |
| 2 Learning average | – | 93.54 | 3.28 | −.08 | – | | | | | | | |
| 3 Mot to transfer | .89 | 3.68 | .58 | .07 | .13 | – | | | | | | |
| 4 Content validity | .74 | 3.62 | .56 | .20* | .01 | .49** | – | | | | | |
| 5 Supv support | .95 | 3.52 | .55 | −.06 | −.17 | .46** | .37** | – | | | | |
| 6 Supv sanctions | .74 | 2.55 | .50 | .31** | −.08 | −.47** | −.27* | −.54** | – | | | |
| 7 Peer support | .83 | 3.78 | .52 | .22* | −.06 | .54** | .48** | .42** | −.45** | – | | |
| 8 Charge resistance | .69 | 2.27 | .58 | .14 | .08 | −.36** | −.46** | −.27** | .47** | −.63** | – | |
| 9 Opportunity to use | .86 | 3.57 | .53 | .03 | −.06 | .58** | .69** | .54** | −.36** | .45** | −.45** | – |

* $p \leq .05$ (one-tailed) ** $p \leq .01$ (one-tailed)

### *Hypothesis two*

The addition of the supervisor support variables (supervisor support and supervisor sanctions) increased explained variance .18, a significant increase ($F_{(2,60)} = 6.93$, $p \leq .01$). The total variance explained by the full model at this stage was significant ($R^2 = .23$, $F_{(5,60)} = 3.57$, $p \leq .01$). The Beta value for content validity approached significance ($b = .24$, $p \leq .08$).

### *Hypothesis three*

The addition of the co-worker support variables (peer support and change resistance) increased $R^2$ by .20, a significant increase ($F_{(2,58)} = 10.07$, $p \leq .01$).

**Table 2** Results of hierarchical regression analysis

| *Predictor* | *b* | $R^2$ | *Adj.* $R^2$ | $F_{model}/df$ | $\Delta R^2$ | $F_{increase}/df$ |
|---|---|---|---|---|---|---|
| *Model 1* | | .02 | −.01 | .57/2,63 | – | – |
| Learning average | −.11 | | | | | |
| Motivation transfer | .10 | | | | | |
| *Model 2* | | .05 | .01 | 1.12/3,62 | .03 | 2.20/1,62 |
| Learning average | −.10 | | | | | |
| Motivation transfer | −.01 | | | | | |
| Content validity | .21 | | | | | |
| *Model 3* | | .23 | .17 | 3.57**/5,60 | .18 | 6.93**/2,60 |
| Learning average | −.07 | | | | | |
| Motivation transfer | .19 | | | | | |
| Content validity | .26 | | | | | |
| Supervisor support | .06 | | | | | |
| Supervisor sanction | .50** | | | | | |
| *Model 4* | | .43 | .36 | 6.29**/7,58 | .20 | 10.31**/2,58 |
| Learning average | −.07 | | | | | |
| Motivation transfer | .04 | | | | | |
| Content validity | .30* | | | | | |
| Supervisor support | −.04 | | | | | |
| Supervisor sanction | .41** | | | | | |
| Peer support | .58** | | | | | |
| Change resistance | .49** | | | | | |
| *Model 5* | | .44 | .36 | 5.65**/8,57 | .01 | 1.10/1,57 |
| Learning average | −.08 | | | | | |
| Motivation transfer | .08 | | | | | |
| Content validity | .37* | | | | | |
| Supervisor support | .01 | | | | | |
| Supervisor sanction | .42** | | | | | |
| Peer support | .57** | | | | | |
| Change resistance | .48** | | | | | |
| Opportunity to use | −.17 | | | | | |

* $p \leq .05$ (one-tailed) ** $p \leq .01$ (one-tailed)

Again, the full model was significant ($R^2$ = .43, $F_{(5,60)}$ = 6.20, $p \leq .01$). The Beta value for content validity reached significance (b = .27, $p \leq .05$).

### *Hypothesis four*

Opportunity to use, the final variable added to the model, produced a .005 change in $R^2$, a non-significant increase ($F_{(1,57)}$ = .48). Total $R^2$ for the model with all variables entered reached .43 ($F_{(8,57)}$ = 5.44, $p \leq .01$). Content validity remained a significant predictor, increasing in influence by .05 (b = .32, $p \leq .05$).

## Supplemental analyses

Because the Beta value for content validity changed from .21 (non-significant) when first entered at step 2 to .32 ($p \leq .05$) in the final model, additional analyses were warranted. This pattern suggested the possibility that one or more suppressor variables were present. A suppressor variable is generally defined as 'a variable which increases the predictive validity of another variable by its inclusion in a regression equation' (Conger 1974: 36). This effect occurs because the suppressor variable removes unwanted variance from the other predictor, thereby improving its predictive power.

Cohen and Cohen (1983) define two possible forms of a suppressor. One form is the reciprocal suppressor (Conger 1974) which occurs when two predictors have positive correlations with the criterion variable, but a strong negative correlation with each other. This pattern is seen with change resistance, which was positively correlated with performance (r = .14) and negatively correlated with content validity (r = -.46), which was positively correlated with performance (r = .20). Thus, when change resistance enters the equation in model 4, content validity becomes a significant predictor because change resistance removes variance that had previously prevented it from being significant. Additional regression analyses that forced the predictors to enter one at a time confirmed it was change resistance not peer support which allowed content validity to become significant.

The second form, which is the more classic form, occurs when one variable ($x_1$) has a zero correlation with the criterion (y), but has a strong correlation with another predictor ($x_2$) which has a positive correlation with the criterion. Mathematically, the correlation of $x_1$ with y must be less than the correlation between $x_2$ and y multiplied by the correlation between $x_1$ and $x_2$. This pattern is evident in the relationship between content validity and opportunity to use. Opportunity to use has almost no relationship with performance (r = .03) but a strong correlation with content validity (r = .69) which is correlated with performance (r = .20). Thus, when opportunity to use entered the equation in model 5, content validity became an even stronger predictor as more variance was removed. This may also explain why opportunity to use has a negative (though non-significant) Beta.

## Discussion

The results of this study make a number of valuable contributions to understanding the transfer process.

### Interpersonal support

Interpersonal support variables accounted for a significant proportion ($R^2$ = .38, $p \leq .01$) of the variance in performance ratings in this study and were the largest contributors to the prediction of learning transfer from among the variables tested. Both supervisor support variables and co-worker support variables explained significant proportions of variance. In addition, peer support and change resistance accounted for significant variance over and above that accounted for by supervisor support and supervisor sanctions. Three interpersonal variables, peer support, group resistance to change and supervisor sanctions, emerged as significant predictors of learning transfer.

These findings indicate that work-group members' beliefs about themselves as a group, normative expectations about group members' work behaviour and the relative absence of opposition to transfer from supervisors were highly influential factors in the use of learning on the job. These findings contradict research (Russell *et al.* 1985; Peters *et al.* 1985) reporting no interaction between social support and training outcomes in field studies. They extend previous work (Seyler *et al.* 1998) to show that interpersonal factors are significant predictors of transfer performance and support suggestions that work-group-level interactions can be important constraints or facilitators of individual performance (Ameel 1992; Baumgartel and Jeanpierre 1972; Hand *et al.* 1973; Hastings *et al.* 1995; Noe *et al.* 1990).

Change resistance assessed perceptions of normative group resistance to introducing new learning from training. Conceptually, resistance to change may result from perceptions that change is difficult or requires a level of work intensity above the norm (Huczynski and Lewis 1980). For instance, it may emanate from perceptions that extra effort will be required to plan how and when to use the training, to overcome the inertia of doing things the 'old way', or actually to apply what was learned. Resistance to change may also come about simply because the changes required by training were introduced from the outside, as was the case in this study where training was mandated by law. The negative predisposition towards mandated training makes the presence of a positive transfer climate (e.g. high levels of peer or supervisor support or low levels of group resistance) even more important for learning transfer. Organizations need to pay special attention to these and other factors in promoting transfer of compulsory training.

Change resistance has received virtually no research in the training literature, although there are indications such a construct may be important. Hastings *et al.* (1995) found that one environmental barrier to transfer was

participants' belief that training would disrupt the functioning of current work groups. Conceptually similar constructs such as openness to experience (Barrick and Mount 1991) at the individual level and continuous learning culture (Tracy *et al.* 1995) at the organizational level have also been shown to be valuable in understanding knowledge acquisition and use. Together with the present findings, the indication is that group-level resistance to change may in some instances be a crucial factor in learning transfer.

Interestingly, the data showed a positive correlation between supervisor sanctions and performance ratings. The supervisor sanctions construct refers to the extent to which supervisors are indifferent to or actively oppose the use of training. A negative correlation with performance ratings was expected based on the rationale that the greater a supervisor's indifference or opposition to training the less trainees would perceive the training as useful. As a consequence, levels of motivation to learn and transfer would be attenuated and performance levels would decrease. Hence, the positive correlation with performance ratings is perplexing.

There are at least two plausible explanations for this unexpected finding. First, the result could have been a function of measurement error. Since the performance measure in this study was based on supervisor ratings of subordinate job behaviour, it is not unreasonable to expect that, if a supervisour opposed or was indifferent to the use of training by subordinates, then job performance ratings of subordinates using training may be negatively affected. The mean scale score for supervisor sanctions was moderate (2.55), indicating that perceptions of supervisory opposition to training were not completely absent. It is therefore possible that rater bias may have been manifested in lower performance ratings for high-performing training users.

An equally tenable interpretation is that supervisory opposition to use of training motivated operators to perform at higher levels. The procedures that went into CATS training were written by subject matter experts (i.e., operators) who performed those procedures as a routine part of their jobs. Supervisors did not participate in writing the procedures, in part because, although familiar with the production processes, they did not routinely perform specific procedures. It is reasonable to assume that, if operators wrote the procedures, they generally perceived the procedures taught in training to be correct and that the use of these procedures on the job would lead to safe and efficient job performance. Data from this study show, in fact, that the procedures were perceived as high in content validity. These considerations may have galvanized operator resistance to supervisor opposition, intensifying their focus on completing procedures correctly. Thus, operators working under sanctioning supervisors performed procedures correctly and received high (and accurate) ratings as a result.

In summary, it is unclear what produced the unexpected positive correlation between supervisor sanctions and performance ratings. Certainly the nature of the work culture and processes that were a part of this study could have created

some unique dynamics. Further research is needed to clarify the relationship between these variables.

## Content validity

This study extends previous research (Clark *et al.* 1993; Hicks and Klimoski 1987; Seyler *et al.* 1998) linking content validity to increased training motivation by showing content validity to be a significant predictor of transfer performance. Performance in this study was linked to training content that explicitly included the knowledge and skills that trainees needed in order to perform their jobs. This finding in part reflects the considerable effort that was devoted in this organization to designing training which accurately reflected job requirements.

The most interesting aspect of this finding is the possibility that change resistance and opportunity to use may act as suppressor variables with regard to content validity. Opportunity to use had no direct effect on performance, but rather influenced performance indirectly through its relationship with content validity. Change resistance had a direct effect on performance, but also an indirect effect through content validity. Thus, content validity was not a significant predictor in early stages of the model, but became significant when these two variables were entered.

Bobko (1995) points out that it is difficult to interpret suppressor variables, particularly in multi-variate regression equations. Thus, we see these findings as only suggesting the possibility that the influence of change resistance and opportunity to use might be somewhat different than previously suggested. To our knowledge, opportunity to use and content validity have not been previously tested together so the suppressor effect might not have been evident. The indirect effects of opportunity to use through content validity seems conceptually plausible and further investigation is warranted.

The findings with regard to content validity also suggest that the relevance of KSAs taught in training to job performance is of fundamental importance for training transfer. Two important implications for training design emerge. First, results support Gagne's (1962) assertion that the highest priority question to be answered by training designers is, 'What is to be learned?' Training needs analysis conducted prior to the design of training provides the basis for accurately answering this question by identifying the specific KSAs that control the performance components of interest. Unfortunately, clarity in answering this question is too often neglected (Campbell 1988). In practice, needs assessments are only infrequently done prior to training design (Saari *et al.* 1988) and the specification of training/behavioural objectives is often neglected (Campbell 1988). The importance of relevant training content supports training researchers (Goldstein 1986; Ostroff and Ford 1989; Rothwell and Sredl 1992; Sleezer 1993; Swanson 1994) who stress that

systematic needs assessment is the crucial first step in establishing a connection between training and performance improvement.

Second, in the absence of needs assessment prior to training design, or in the case of existing training courses whose content is based on a past, and possibly outdated, analysis, these findings suggest the value of ongoing evaluations of training content and objectives. A number of techniques for pre-testing or assessing content relevance prior to training have been forwarded (e.g., Ford and Wroten 1984; Goldstein 1986; Wexley 1984). Using techniques such as these would (a) verify the validity of training content a priori, a factor which could enhance trainee motivation; (b) increase training effectiveness by allowing for content modifications where needed; and (c) facilitate training evaluation by establishing the job relevance of training so that the impact of other variables on training effectiveness could be better appraised.

## Criterion measure

An important strength of this study was the performance measure used and the criterion development process that was presented. Specifying valid units of performance is critical to understanding the change that occurs in job performance as a result of training transfer. However, the lack of attention to criterion measurement in human resources research is one of the most challenging areas facing researchers and practitioners today. The use of supervisory ratings of performance was a small step towards overcoming the nearly exclusive reliance on self-report measures evident in transfer of training research. The criterion development process used in this study ensured the rating instrument had high content validity. We believe this process is informative as a guide for other researchers and practitioners who seek to develop sound criterion measures.

## Non-significant predictors

Interpretation of non-significant predictors was not undertaken in this paper. *Post hoc* power analysis indicated that only the last step of the regression model had adequate power (.996) to detect significant effects. However, this does add strength to our finding of a possible suppressor effect for opportunity to use, even though it was a non-significant predictor, because the analysis did have adequate power to detect even a small effect size in opportunity to use.

Step two, in which content validity was entered, had moderate power (.47) whereas the remaining steps had very low power (.004 – .20). The low power of these steps made reasonable interpretation of non-significant findings difficult because it was not possible to determine whether the effects of those predictors were truly non-significant, or just not detectable in this analysis. This does not, however, diminish the value of the significant findings where

adequate power was present. In short, the sample size generated sufficient power to detect large effects but not small, yet potentially important effects.

## Study limitations

There are several potential limiting factors with regard to these findings. First, the cross-sectional nature of the study means the causal relationships between variables can only be inferred. Second, generalizability is limited due to the purposive nature of the sample from which data were collected. Finally, although steps were taken to ensure confidentiality, responses to the data-collection instruments may have been influenced by social desirability, fear of reprisal or some other unmeasured factor. Not one of these limitations was believed to have seriously compromised the quality of the study.

## Implications for research and practice

Evidence in this and other research (e.g., Seyler *et al.* 1998) increasingly points to the crucial role that supervisors, managers, peers/workgroup members and trainers can play in the success or failure of learning transfer. The implication is that these key players must have a set of transfer-related competencies in order to maximize learning transfer in the workplace. For example, they need the ability to partner one another to identify critical training needs, prepare trainees for learning and transfer prior to training, and to motivate, coach, provide opportunities for and reinforce learning transfer after training. The absence of these and other important transfer-related competencies represents a major barrier to successful learning transfer.

In practice, however, organizations have done little to provide or develop these competencies, largely because they have yet to be explicitly defined. Research is needed to identify (a) the competencies that supervisors, managers, peers/workgroup members and trainers need to support learning transfer; (b) the specific knowledge, skill and ability components of these competencies; (c) the implications for human resource systems (e.g., performance appraisal, compensation, selection, job analysis) of developing and supporting the use of transfer competencies. This information would provide the foundation upon which organizations could design and provide comprehensive and systematic programmes to build and promote the use of transfer support skills and competencies.

In addition, research has yet to fully describe when interpersonal support variables will facilitate training transfer, when they will not, or why. Although both supervisory support and co-worker support are regarded as multi-dimensional constructs (Baldwin and Ford 1988), this study was the first to develop measures of and examine multiple dimensions of these constructs. Further research is needed to (a) validate these measures; (b) identify and test for other core dimensions of interpersonal support; and (c) examine the

interactions of these variables with other potentially important transfer variables such as opportunity to use, feedback or rewards. Full specification and testing of the dimensions of interpersonal support is a prerequisite for increasing our understanding of how these important variables work with different kinds of training in different settings. It will also facilitate the development of appropriate interventions to provide supervisors and co-workers with the tools they need to support learning transfer effectively.

The present study is consistent with other research (e.g., Alliger and Janak 1989; Noe and Schmitt 1986; Mathieu *et al.* 1992), indicating that there are critical variables outside the training programme that can affect learning transfer. The present research showed that interpersonal variables can significantly influence the prediction of transfer. Had these variables not been examined in an evaluation of the present training programme, the only conclusion that would have been possible, given inadequate performance levels as a result of learning training, was that something was wrong with the training programme. Consequently, without evaluation of variables inside and outside the training programme itself, incorrect decisions about how to improve training effectiveness could have been made. The implication for practice is that understanding the complexity of influences on training effectiveness, which are typical of workplace training, requires a model of training effectiveness rich enough to identify system-wide factors which may influence training outcomes.

Unfortunately, a fundamental area in which transfer research is deficient is in modelling the learning-transfer process. Researchers have for some time recognized the necessity of building comprehensive, integrated models of the learning-transfer process in order fully to understand and reliably to identify the causes and effects of training success or failure (Alliger and Janak 1989; Facteau *et al.* 1995; Holton 1996; Kozlowski and Salas 1997; Noe and Schmitt 1986). Several models have recently been proposed (e.g., Rouiller and Goldstein 1993; Tracy *et al.* 1995; Xiao 1996), but very limited research has been done with them. Not one of the models has been validated by subsequent studies nor have many of the constructs proposed by the models been tested in further research. Consequently, transfer research lacks an accepted theoretical framework for evaluating critical factors. Additional research is clearly needed to refine and validate a model of training effectiveness that can help explain more fully why training does or does not lead to performance improvement.

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