Models Of Team Performance:

What’s The Real Effect Of Team Processes On Team Performance?

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Abstract

Several different versions of the Input-Process-Outcome (IPO) model of team performance suggested by Hackman and Morris (1987) were tested with 81 work teams. The input variables of team composition of skills and abilities, task design, and work-task norms predicted outcome measures when mediated by the process variables of utilization of knowledge and skills, team effort, and task performance strategies, respectively.
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In an effort to increase employee and organizational performance, many organizations have implemented work teams. Research suggests that utilization of teams can improve task performance (Goodman, Devadas, & Hughson, 1988) and productivity (Whyte, 1955), and can reduce interpersonal conflict (Alderfer, 1977). The input-process-outcome (IPO) model pervades theory and research on team process and performance. McGrath's (1964) IPO model has served as a prototype for the development of other IPO models (e.g., Gladstein, 1984; Goodman, Ravlin, & Argote, 1986; Hackman, 1983, 1987; Hackman & Morris, 1975; Hackman & Oldham, 1980; Pearce & Ravlin, 1987; Shea & Guzzo, 1987; Sundstrom, De Meuse, & Futrell, 1990).

Although IPO models have attracted a great deal of attention, few empirical studies have actually tested their ability to predict team performance (cf. Gladstein, 1984). Even research directly testing these models has not offered strong confirmation of their ability to predict team outcomes (e.g., Hackman & Morris, 1975). In addition, tests of IPO models have frequently been conducted in laboratory settings, which critics have argued cannot possibly include all of the relevant variables that would realistically occur in an organization (Guzzo & Shea, 1992).

The current study attempted to enrich existing empirical research on the prediction of team performance by testing a model similar to Hackman's normative IPO model (Hackman, 1983, 1987; Hackman & Morris, 1975; Hackman & Oldham, 1980). The variables included in the hypothesized model (see Figure 1) were chosen based on Hackman's normative IPO model and subsequent theory and research (Campion, Papper, & Medsker, 1996; Gladstein, 1984). SEM was used to test the proposed IPO model's ability to predict team effectiveness in an organizational setting using intact work teams. A longitudinal design was employed to test the effects of process interactions on team performance and the causal relationships in the IPO model (Hackman & Morris; McGrath, 1964; Tuckman, 1965)—which was also tested against several alternative models. The focus of this study was to test a longitudinal IPO team process model.
Models of Team

Teams

When considering traits relevant to performance, it is necessary to distinguish between teams and groups. Contrary to groups (whose members tend to be homogeneous in terms of tasks, roles and expertise), teams consist of two or more individuals that can be characterized by high task interdependence, high role differentiation, high task differentiation, and distributed expertise (Salas, Dickinson, Converse, & Tannenbaum, 1992; Sundstrom et al., 1990). The work teams which participated in the current study possessed these characteristics. As a result, each team member had specialized knowledge and skills and had to coordinate and interact with other team members sequentially or simultaneously (Dickinson & McIntyre, 1997). This increased task and interpersonal interdependence increased the complexity of team member interaction.

Aggregation

When being used as predictors of group-level outcomes, individual team member behaviors or traits must be aggregated in some fashion. How this data should be aggregated depends upon the type of group process interaction—which is dependent upon the type of task (Steiner, 1972). In this study, team tasks were characterized by high task interdependence, high role and high task differentiation, and distributed expertise. Because there was some overlap in task responsibilities between members, team performance was measured via mean scores.

Input-Process Links

The input variables in the hypothesized model included team composition of skills and abilities, task design, and work norms. These inputs are linked to the processes of knowledge and skill utilization, effort, and task performance strategies, respectively. It has been argued (Hackman, 1983, 1987; Hackman & Morris, 1975; Hackman & Oldham, 1980) that these three input-process links would not be operative at the same time, but would be dependent upon task type. In the current study we challenged this argument by positing that in a team situation it is possible that all of these process links could be applicable simultaneously because of the increased interdependence and interaction required with teams.
Operationalization of Outcomes

The last stage in the IPO model (Hackman 1983, 1987; Hackman & Morris, 1975; Hackman & Oldham, 1980) includes the desired team outcome measures that result from process effects. Outcomes have typically been defined and measured as some criteria of team goal accomplishment, such as dollars of revenue, percent of quota achieved, or a supervisory rating of team performance (Argote, 1982; Campion, Medsker, & Higgs, 1993; Gladstein, 1984; Goodman, 1979; Kolodny & Kiggundu, 1980; Pearce & Ravlin, 1987; Walton, 1972).

Linkages between process and outcome variables can be developed on both theoretical and conceptual bases. The process measures of effort, task performance strategies, and knowledge and skill utilization are expected to increase task-related performance measures such as quota achieved, work completed, and supervisory task ratings. Research has shown that higher effort increases performance (Earley, Northcraft, Lee, & Lituchy, 1990; Weingart, 1992), and that performance strategies impact quality and quantity of outcomes (Davis, 1973; Maier, 1963; Stone, 1971). Strategy development’s positive effects have been seen with crews of coal miners (Goodman et al., 1986) and wood harvesters (Kologny & Kiggundu, 1980). Lanzetta & Roby (1960) also found a relationship between knowledge and skill utilization and various outcomes.

Longitudinal Relationships

Research indicates that there are strong temporal dimensions to team performance (Kelly, 1988; Kelly, Futran, & McGrath, 1990; McGrath, Kelly, & Machatka, 1984); thus, effective measurement of IPO models requires a longitudinal approach. Specifically, input, process, and outcome variables should be measured once after the team intervention has been in place for a given time, and they should again be measured to determine whether team processes have the desired effects over time. Figure 1 describes the hypothesized relationships among the variables in the proposed IPO model at a single point in time. The magnitude, direction, and pattern of these relationships are expected to be consistent over time.
Alternative Models

A basic premise of the IPO model holds that inputs only affect outcomes through the mediational effects of the process variables (Hackman, 1987). However, two alternatives to this fully-mediated model have been proposed. One alternative model suggests an indirect effect of team inputs on team outcomes through team interaction processes, while also showing a direct effect of inputs on outputs. This partially-mediated model implies that the effect of process measures on the input-output relationship is weaker than that held by the fully-mediated model. Another model proposes that inputs directly affect both team processes and outcomes with no process-outcome relationships (Campion et al., 1993; Campion et al., 1996). This direct effects model eliminates the mediating role of process measures and treats process measures as outcome variables. The viability of each of these alternative models was examined in the current study.

Unconstrained Models

Hackman (1983, 1987) and other researchers have also explored additional input-process links (Spich & Keleman, 1985). For example, weaker links between task design and task performance strategies have been specified (Hackman, 1983, 1987). In addition, Seashore (1954) revealed a relationship between work norms and team effort. As a result, the effect of adding these links to the hypothesized model was tested using two separate alternative models.

Based on the preceding discussion, four hypotheses were developed (see Figure 1):
H1: Utilization of knowledge and skills mediates the relationship between team composition of skills and abilities and outcomes.
H2: Team effort mediates the relationship between task design and outcomes.
H3: Task Performance strategy mediates the relationship between work norms and outcomes.
H4: The relationships proposed in hypotheses 1 – 3 will be consistent across time.

Method

Participants

Participants consisted of 323 employees organized into 81 work teams in a Midwestern branch of a large retail department store. Slightly more than half of the participants (52%) were
female. The age distribution of participants was skewed toward younger employees: 40% of the participants were less than 30 years of age; 31% were between 30 and 39 years of age; 20% were between 40 and 49 years of age; and 5% were age 50 or older. Average company tenure was 4.5 years (SD = 4.22) and average job tenure was 2.3 years (SD = 2.78). Of the 323 employees, 73% held a high school degree with no college experience, 21% had some college experience, and 6% held an associate's degree.

Employees worked in four-person teams (with the exception of one team that had only 3 members) in a variety of departments (e.g. hardware, automotive, clothing, jewelry). Each team was responsible for the sale of merchandise, stock maintenance, inventory control, and other customer service needs within its department. Each of the task functions required specialized training; hence, task functions were not readily transferred from one team member to another. Team members specialized in a particular task function and were considered experts (for example, in inventory control). Teams were also responsible for hiring new members, safety, scheduling work assignments, and quality assurance. The high level of interdependence among members in terms of problem solving and collaborating to complete job responsibilities classified their tasks as requiring team interdependence (Saavedra, Earley, & Van Dyne, 1993).

Measures and Procedure

Multiple measures were obtained to operationalize each of the theoretical constructs. When feasible, data were collected from multiple sources to minimize common method variance. Team inputs were measured at the individual level and then aggregated; both team process and outcomes were measured at the team level. The data collection timetable is shown in Table 1. Due to low turnover (16%) in team members, employee attrition was not considered a threat to validity. Measures are available from the first author on request.

Results

Aggregation

Because the current study focused on team outcomes, many variables in the IPO model were measured at the team level. However, inputs were measured at the individual level and then
aggregated. To warrant the use of aggregated data, several statistical conditions must be met. To justify aggregation to the team level, it is necessary to show agreement of individual responses within teams. James, Demaree, and Wolf's (1984) measure of within-team agreement ($r_{wg}$) for a multiple-item scale provides a unique estimate for each team and is interpreted as an indicator of perceptual convergence within the team (Kozlowski & Hattrup, 1992). Values of .70 or higher are necessary to demonstrate homogeneity within each team (George, 1990). Estimates were computed using the James et al. (1984) procedure and are provided in Tables 2 and 3. Average values for $r_{wg}$ are indicated. All of these estimates were within the acceptable range (i.e., .70 or higher). In addition, reliable between-team differences should also be shown before aggregating (James, 1982). Adopting the technique of George and Bettenhausen (1990), separate one-way analyses of variance (ANOVAs) were computed to show between-team differences for aggregated variables. All of the aggregated variables met the criterion set by Hays (1987) of an $F$ value greater than 1.0, indicating adequate between-team variance.

Finally, with team research there is always the concern that individual-level variables may violate the assumption of independence of observations (Hoyle & Crawford, 1994). Kenny and Judd (1986) have suggested an analysis of variance (ANOVA) procedure to determine the possibility of non-independence due to the aggregation of variables. Three separate ANOVAs were run for each of the input variables (team composition of skills and abilities, task design, and work norms) based on items in the measurement model as outcomes. To meet the independence assumption, Kenny and Judd recommend an $F$ ratio that is neither meaningfully less than nor greater than 1. All of the predictors in the current study met this criteria: team composition of skills and abilities, $F(79, 239) = 1.01$; team composition of attitudes and personality, $F(79, 239) = .96$; task design, $F(79, 239) = 1.05$; and work norms $F(79, 239) = 1.03$.

Descriptive Statistics

The means, standard deviations, and correlations for Phase 1 and 2 are reported in Tables 2 and 3, respectively. Coefficient alphas are also provided in Tables 2 and 3. All alphas exceeded .70, the minimum established by Nunnally (1978).
Structural Equation Analyses

Prior to main analyses, the data was evaluated to insure that SEM assumptions were met. Residuals were examined for magnitude, linearity, independence, normality, and homogeneity of variance (Cohen & Cohen, 1983). No violations of these assumptions were identified. No outliers or influential data points were identified by Mahalanobis's D or Cook's Distance (Cohen & Cohen). The Durbin-Watson test did not identify multicollinearity to be a problem.

To simultaneously test the proposed IPO model and several alternative models, data was analyzed with SEM techniques using LISREL VIII (Joreskog & Sorbom, 1993), which provides an overall chi-square value indicating the extent to which observed covariance or correlation matrices differ from a reproduced matrix determined by the estimated model parameters. Because chi-square values are dependent on sample size (Schmitt & Stults, 1986), large samples may result in significance for proposed models. Therefore, the non-normed fit index (NNFI; Bentler & Bonett, 1980) was computed to assess the appropriateness of each model. The NNFI is less sensitive to variations in sample size (Marsh, Balla, & McDonald, 1988). By convention, NNFI values exceeding .90 indicate acceptable fit. The following fit indices were also computed: CFI, RMSEA, and PGFI.

In order to adjust for measurement error in the scale scores, the path from the latent variable to its indicator was set equal to the square root of the scale's internal reliability. The error variance was set equal to the variance of the scale score multiplied by one minus the reliability. This approach has been explained by Williams and Hazer (1986) and Joreskog and Sorbom (1993), and has been demonstrated as a reasonable approximation in determining error variance (Netemeyer, Johnston, & Burton, 1990).

Structural models. The structural null model (or independence model) includes no relationships among the latent variables and serves as a comparison to determine the improvement in fit for the other models tested. As expected, this model did not provide an adequate fit for the data, $\chi^2 (36) = 114.44$, $p < .001$. 
After assessing the fit of the null model, a series of nested model comparisons were conducted to determine if the relationships between team inputs and outcomes were mediated by the team process variables. The results of the nested model comparisons are reported in Table 4. The partially-mediated model, also referred to as Model 2, includes all of the direct and indirect effects of team inputs, processes, and outcomes (Hackman’s direct and indirect model). As shown in Table 4, this partially-mediated model had a chi-square of 13.64, with 15 degrees of freedom (RMSEA = .000; CFI = 1.00; NFI = .88; PGFI = .32).

Model 3 is identical to Model 2, except that the three paths leading from the team inputs to team processes were omitted. As shown in Table 4, the chi-square for Model 2 was 62.38 with 18 degrees of freedom, \( p < .001 \). The significant difference in chi-square values between Model 3 and Model 2, \( \Delta \chi^2(3) = 48.74, p < .001 \), indicated that effects of team inputs on team processes made an important contribution to the overall fit of the model and should not be omitted.

Model 1 is the hypothesized fully-mediated model. It is identical to Model 2, except the direct effects of team inputs to team outcomes have been omitted. The chi-square difference between Model 1 and Model 2 was not significant (\( \chi^2[9] = 5.63, p > .05 \)), indicating that these paths did not improve the model fit and should be omitted.

Model 4, the direct effects model, was identical to Model 2 except the nine paths leading from processes to outcomes were omitted. The difference in chi-square values between Model 2 and Model 4 was significant (\( \chi^2[9] = 43.39, p < .001 \)), indicating that the paths leading from processes to outcomes are important and should be included. The results of these nested model comparisons suggest that the hypothesized, fully-mediated model was the best alternative.

In addition to the nested model comparisons, two models adding certain paths from inputs to processes were tested to see if the addition of these paths significantly changed the fit of the model (for rationale see Anderson & Gerbing, 1988). Model 5 is identical to Model 1, except a path has been added leading from task design to task strategy as suggested by Hackman and Morris (1975). A comparison of the chi-square values for Model 1 and Model 5, \( \Delta \chi^2(1) = 0.83 \),
Model 11

Model 6 is identical to Model 1, except a path has been added leading from work norms to team effort. Hackman and Morris also suggested this possible path. A comparison of the chi-square values for Model 1 and Model 6, \( \Delta \chi^2 (1) = 1.24, p > .05 \), indicated that this path does not improve the fit of the model and should not be included.

Significance of individual paths. The model comparisons discussed above were conducted to test the aggregate, not the individual relationships depicted in Figure 1. After completing the preceding model analyses, the significance of the individual paths in the best-fitting model were assessed. Figure 2 shows these path coefficients at Phase 1 and Phase 2.

In examining the various relationships for Phase 1, all of the hypothesized paths from the team inputs to team processes were significant: composition of skills and ability to utilization of knowledge and skills (\( t = 3.98, p < .001 \)); task design to team effort (\( t = 4.43, p < .001 \)); and work norms to task performance strategies (\( t = 4.20, p < .001 \)). However, as expected and shown in Figure 2, not all of the process to outcome relationships were significant. The following paths from process to outcomes were statistically significant: team effort to supervisory task rating (\( t = 3.83, p < .001 \)); task strategy to quota achieved (\( t = 3.53, p < .001 \)); knowledge and skill utilization to work completed (\( t = 3.48, p < .001 \)); and knowledge and skill utilization to quota achieved (\( t = 2.18, p < .05 \)).

Consistency of relationships over time. Because the hypothesized model was identified as the best-fitting alternative in the preceding analyses, this model was re-estimated using data from Phase 2. In general, the estimates for individual paths obtained using the Phase 2 data were consistent with estimates for the same paths obtained using Phase 1 data. All of the hypothesized input to process paths were statistically significant: composition of skills and ability to utilization of knowledge and skills (\( t = 4.36, p < .001 \)); task design to team effort (\( t = 4.09, p < .001 \)); and work norms to task performance strategies (\( t = 3.60, p < .001 \)). The following paths from process to outcomes that were statistically significant in Phase 1 were also significant at Phase 2: team effort to supervisory task rating (\( t = 3.69, p < .001 \)); task strategy to quota achieved (\( t = 3.46, p <
knowledge and skill utilization to work completed ($t = 3.22, p < .001$); and knowledge and skill utilization to quota achieved ($t = 2.07, p < .05$). In addition, the path leading from knowledge and skill utilization to supervisor task ratings was statistically significant at Phase 2 ($t = 2.36, p < .05$). The correlation between path estimates obtained using Phase 1 data and path estimates obtained using Phase 2 data, $r = .998$, indicated a high level of consistency for these relationships across time.

Discussion

In the current study, alternative models of input-process-outcome relationships of team performance were tested and compared. The results support the viability of the hypothesized model to predict team performance. The current results also provide support for the viability of an IPO model to team situations where the level of task and interpersonal interdependence and interaction is increased. The model in the current study was intended to be only one of many possible approaches to representing IPO team relationships. Future research should consider testing other IPO models with the use of other combinations of variables.

Because process variables were measured one year after the implementation of the inputs, and outputs were measured one year after the processes, the relationships between IPO model components are now longitudinally established. Specifically, processes seem to develop over time which facilitate the achievement of outcomes. The magnitude of correlations across time in this study are consistent with results found in other studies on teams (Barrick, Stewart, Neubert, & Mount, 1998; Barry & Stewart, 1997; Campion et al., 1993; Campion et al., 1996; Gladstein, 1984).

The fully-mediated model provides the best fit compared to the alternatives tested. Although Campion et al. (1993) found direct effects from inputs to outcomes, their study did not use a longitudinal design or account for the mediating effects of processes. While all of the effects from inputs to process variables are moderate, the strongest effects are from task design to team effort and from composition of skills and abilities to utilization of knowledge and skills. For the tasks in the current study, the relationships specified in the theoretical model provide the
best fit. We would expect that for other populations and tasks, the input-process-outcome relationships would be different. That is, different input, process, and outcome paths might be significant due to differences in task requirements. The current study provides only one test of the IPO model with a limited set of variables. If additional variables were considered, some of the relationships may change.

One limitation in the current study is that the relationships from process to outcomes appear to be lower after four years compared to the effects after three years. However, the strength of the relationships between inputs and processes remain stable across time. While the relationships between processes and outcomes are significant (p < .05) after four years, the lower correlations indicate that these effects may weaken over time. This indicates that organizations should maintain training and development programs to reinforce team skills for employees.

Overall, the findings are supportive of a mediational approach to team development. This is in agreement with other research (Barrick et al., 1998; Barry & Stewart, 1997; Gladstein, 1984) which has provided preliminary evidence for a mediational model of team performance. For different types of tasks or jobs, the team interactions would differ and the results of a mediational model of team development might be operationalized with a different combination of variables.
References


schemes. Psychological Review, 80, 97-125.


Figure 1. IPO Model of Team Effectiveness

All values are standardized path coefficients. The first value on each path was derived using data from Phase 1; the second value in parentheses was derived using data from Phase 2. * $p < .05$, ** $p > .001$. 
Table 1

Time-Line for Collection of Longitudinal Data

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<th>Time</th>
<th>Event</th>
<th>Year</th>
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<tr>
<td></td>
<td>Team Training Intervention</td>
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<tr>
<td>Phase 1</td>
<td>Collection of initial input variable data from teams</td>
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<tr>
<td></td>
<td>Collection of initial process variable data from human resource staff</td>
<td>2</td>
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<tr>
<td></td>
<td>Collection of initial outcome measures</td>
<td>3</td>
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<tr>
<td>Phase 2</td>
<td>Collection of follow-up input, process, and outcome measures</td>
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### Table 2

Descriptive Statistics and Correlations for Phase 1 (N = 81)

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<th>Variables</th>
<th>M</th>
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<th>r^a</th>
<th>r^b</th>
<th>r^c</th>
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<td>.68**</td>
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<td>3. Work Norms</td>
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<td>.69**</td>
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<td>5.77</td>
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<td>.86**</td>
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<td>.73**</td>
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<td>.87</td>
<td>.70**</td>
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<td>7. Quota Achieved</td>
<td>74.50</td>
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<td>8. Work Completed</td>
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Table 2 (continued)

Descriptive Statistics and Correlations for Phase 1 (N = 81)

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<td>.35**</td>
<td>.16</td>
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<td>7. Quota Achieved</td>
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<td>.22*</td>
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<td>8. Work Completed</td>
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<td>.30**</td>
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* p < .05. ** p < .01. a Internal Consistency Reliability. b Interrater Reliability. c Interrater Agreement.
Table 3

Descriptive Statistics and Correlations for Phase 2 (N = 81)

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<tr>
<td>3. Work Norms</td>
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<td>.68**</td>
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<td>4. Team Effort</td>
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<td>.86**</td>
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Table 3 (continued)

Descriptive Statistics and Correlations for Phase 2 (N = 81)

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<td>.03</td>
<td>.05</td>
<td>.20*</td>
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<td>.37**</td>
<td>-.05</td>
<td>-.01</td>
<td>.07</td>
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<td>4. Team Effort</td>
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<td>.06</td>
<td>.15</td>
<td>.36**</td>
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* p < .05. ** p < .01.  a Internal Consistency Reliability.  b Interrater Reliability.  c Interrater Agreement.
### Table 4

**Model Analysis for Phase 1 and Phase 2**

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<th>CFI</th>
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<td>23</td>
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* $p < .05$, ** $p < .01$, *** $p < .001$