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VALIDATION OF THE TRAINING PROGRAM EVALUATION RESEARCH INSTRUMENT: A STRUCTURAL EQUATION MODELLING APPROACH

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ABSTRACT

The paper reports the results of our research study identifying the statistically significant factors that influence the validation of Research Instrument used in Training Program Evaluation at Agricultural Research Institutes, Hyderabad. The data collected using a survey of 200 trainee participants including 60 women and 140 men, from eight training courses to assess the program participant satisfaction and performance. Ten factors were used in the study and using the factor analysis four variables were eliminated because of the poor factor loadings. The remaining six factorsLectures, Practical, Demos, Field Visit, Methodology, and Instructor ability used for this study to measure Performance.The Likert data was collected using a structured undisguised questionnaire. We have applied the descriptive analysis, correlationtechniques, inferential statistics, and Structural Equation Modellingto arrive conclusions. To measure the reliability of thescale used for this study, and internal consistencies of the survey questionnaire, the reliabilitystatics Cronbach's alpha and Spearman-Brown split-half reliability were used. The overall Cronbach alpha is 0.95and the Cronbach alpha value ranged from 0.82 to 0.94 for all the 9 independent and one dependent variables.A series of models were evaluated on 60 items of the initial questionnaire allowing Structural Equation Model (SEM) to identify the best-fit factors that influence the Research Instrument Validation used in Training Program Evaluation. The study observed that model was statistically significant and consistent and the instrument was validated for routine use.

Keywords: Training, Cronbach alpha,Modelling, Validation, Instrument

1. INTRODUCTION

The rapid advancement in science, modernization of science and technological changes envisaged agricultural research sector to look for new methods of training in the area of crop improvement. Most of the studies on training evaluation focussed on the impact of the training in improving efficiency and productivity of employees. However there were very limited work has been reported on addressing the core and central aspect of the training, its content and methodology [1]. This study focussed on evaluating the factors that influencing the training program outcome post-training Performance.

Training evaluation is an integral part of most training programs. The evaluation tools and methodologies help to determine the effectiveness of instructional interventions. Despite its importance, there is evidence that evaluations of training programs are often inconsistent or missing [2]-[5]. Possible explanations for inadequate evaluations include: insufficient budget allocated; insufficient time allocated; lack of expertise; blind trust in training solutions; or lack of methods and tools [6].The evaluation of training is complex and training interventions with regard to learning, transfer, and organizational impact involves a number of complexity factors. These factors are associated with the dynamic and rapid changes in science and technology and compelled the organizations like international agricultural research institute to envisage frequent changes in the structure, instructional methods and content of the trainings they offer [7]. The more complex situation where training cannot not make any substantial change when organizational performance is constrained by the structure of the organization, local and national priorities, or legislation and policies [8].

Several researchers highlighted in their evaluation about the training and its effect on job performance. According to Burke and Day(1986)[9] training positively influences the performance of the managers. As per Bartel (1994) [10] the investment in training increases the productivity. McIvor (1997) [11]argues that it influences organizational commitment, participant knowledge and organizational based self-esteem. Hamblin (1970) [12]defined evaluation of training as – Any attempt to obtain information (feedback) on the effects of training programme and to assess the value of training in the light of that information for improving further training.

Considering the several theories, aspects and complexities the research study proposed evaluated the eight training programs spread over three years using six above said independent variables to measure the Performance of the training program using Structural Equation Modelling (SEM Approach)

a) Structural Equation Modelling

Structural equation modelling (SEM) is a methodology for representing, estimating, and testing a network of relationships between variables (measured variables and latent constructs). This tutorial provides an introduction to SEM including comparisons between “traditional statistical” and SEM analyses. Examples include path analysis/ multiple, repeated measures analysis/latent growth curve modelling, and confirmatory factor analysis. Participants will learn basic skills to analyze data with structural equation modelling [13]. SEM is a very general statistical modelling technique, which is widely used in the behavioural sciences and can be used as a combination of factor analysis and regression or path analysis. The relationship between the theoretical constructs are represented by regression or path coefficients. The SEM implies a structure for the covariances between the observed variables.

The SEM has roots in path analysis, which was invented by geneticist Sewall Wright [14]. In general SEM notation is represented by Path-Diagram consisting of boxes, circles, which are connected by arrows. The observed (measured)variables are represented by a rectangle or square box, and latent (or unmeasured) variables are represented by circles. Single headed arrows use to define causal relationships in the model, with the variable at the tail of the arrow causing the variable at the point. The double headed arrows indicate covariance or correlation without a causal interpretation. Statistically the single headed arrows or paths represent regression coefficients and double-headed arrows covariances [15].

2. REVIEW OF LITERATURE

Training evaluation is defined as the systematic process of collecting data to determine if training is effective [16]. The Commonly used training evaluation has their roots in systematic approaches to the design of training. They are typified by the instructional system development (ISD) methodologies, which emerged in the USA in the 1950s and 1960s and are represented in the works of Gagné and Briggs (1974), Goldstein (1993), and Mager (1962) [17]-[19]. Evaluation is traditionally represented as the final stage in a systematic approach with the purpose being to improve interventions (formative evaluation) or make a judgment about worth and effectiveness (summative evaluation)[20] More recent ISD models incorporate evaluation throughout the process [21]. Neeraj et al. (2014)[22] in his case study approach presented evaluation of employee training and its effectiveness elucidated his findings using descriptive statistics and Likert scale with hypothesis testing.

Madgy (1999) evaluated the sales force training effectiveness measuring empirically using statistical methods [23]. Veermani and Premila Seth (1985) defined evaluation as an attempt to obtain information on the planning of training, the conduct of the training and feedback on the application of learning after the training so as to assess the value of the training. This evaluation finding may be used for a variety of purposes[24].

The Kirkpatrick (1976) developed four logical levels framework for training evaluation consisting of reaction, learning, behaviour and results. Most of the training programs evaluate reaction and learning levels and other two levels learning and behaviour often not done because of their complexities. Some researchers argue that training should result in some form of behaviour change [25].

Phillips (1999) stated the Kirkpatrick Model was probably the most well-known framework for classification of areas of evaluation. This was confirmed in 1997 when the American Society for Training and Development (ASTD) assessed the nationwide prevalence of the importance of measurement and evaluation to human resources department (HRD) executives by surveying a panel of 300 HRD executives from a variety of types of U.S. organizations. Survey results indicated the majority (81%) of HRD executives attached some level of importance to evaluation and over half (67%) used the Kirkpatrick Model. The most frequently reported challenge was determining the impact of the training

(ASTD, 1997) [29]. Lookatch (1991) and ASTD reported that only one in ten organizations attempted to gather any results-based evaluation [26].

Structural Equation Modelling: The use of Structural Equation Modelling (SEM) in research has increased in psychology, sociology, education, and economics since it was first conceived by] Wright (1918), a biometrician who was credited with the development of path analysis to analyze genetic theory in biology [27]. In the 1970s, SEM enjoyed a renaissance, particularly in sociology and econometrics [28]. It later spread to other disciplines, such as psychology, political science, and education [29]. The growth and popularity of SEM was generally attributed to the advancement of software development (e.g., LISREL, AMOS, Mplus, Mx) that have increased the accessibility of SEM to substantive researchers who have found this method to be appropriate in addressing a variety of research questions [30]. Some examples of these software include LISREL (LInear Structural Relations) by [31]-[34].

Isaac Baafi Sarbeng (2013) [35] applied Structural Equation Modelling for Staff Training and Development Interventions and Teaching Performance revealed that although the training programmes are not perceived as fair enough, it has positively affected staff professional knowledge, intellectual planning, class attendance and assessment.

Stronge (2012) [36] contended that performance indicator is a tangible behaviour that can be observed or documented to determine the degree to which the standards are met.

In summary the literature suggests a strong relationship between training and post-training performance i.e. ability to improve his knowledge and apply the learned knowledge in his/her routine job assignments The purpose of the pr esent study is to explore the relationship between the said six independent variables with dependent variable on training participants improved performance on his/her knowledge through the training.

3. OBJECTIVES

Research Question

Does there is any relation overall training program methodology participant's satisfaction for Research Instrument Validity?
With the above background this study has the following objectives:

- To determine the trainee perceived Satisfaction
- To evaluate whether the objectives were achieved.
- To find out if the provided training course factors met the participant needs.

4. RESEARCH METHODOLOGY

4.1 Conceptual Framework

Based on the above discussions and other empirical perspectives we adopted the conceptual framework guided by the Stronge (2012) [36] was taken as a model for developing our framework (Figure 1). The dependent variable in this study is Effectiveness of training program and six independent variables used in this study are Lectures, Practical, Demos, Field Visit, Methodology and Instructorand the 60 Items are listed our in the Table 1.

Table 1. Factors of the study

Sl No	Factor	Items related to factor
1	Knowledge	6 items, Knowledge on the subject, ability to link the subject, theory, practice, latest know-how on the subject Analytical acumen, communication skills
2	Practical	6 items, time of practical, lab space, scope, lab analyst knowledge, supplies, etc
3	Course Delivery	6 items, systematic deliver, time usage, delivery mechanism, coverage, content mastery.
4	Field Visit	6 items transition from theory to practice, field experiments, understanding practical, field demos, application,
5	Methodology	10 items skills in preparation of exams, quizzes, goals, expectation

		of students, document learning, student alignment, documentation, etc
6	Instructor	6 items Instructor skills, knowledge, ability to clearly explain, effective interaction etc.
7	Course Content	5 Items subject relevancy, modern techniques, latest course subjects, etc.
8	Length of Course	5 Period of the course, practical time, demo time, theory time etc.
9	Overall Satisfaction	5 factors Involvement of staff, training suitability, monitoring, review, exams Relevance of the training
10	Performance	5 Effect of training on performance, improve ins staff ability in carrying the assignments, increased aptitude to apply the learned knowledge, sense of achievement

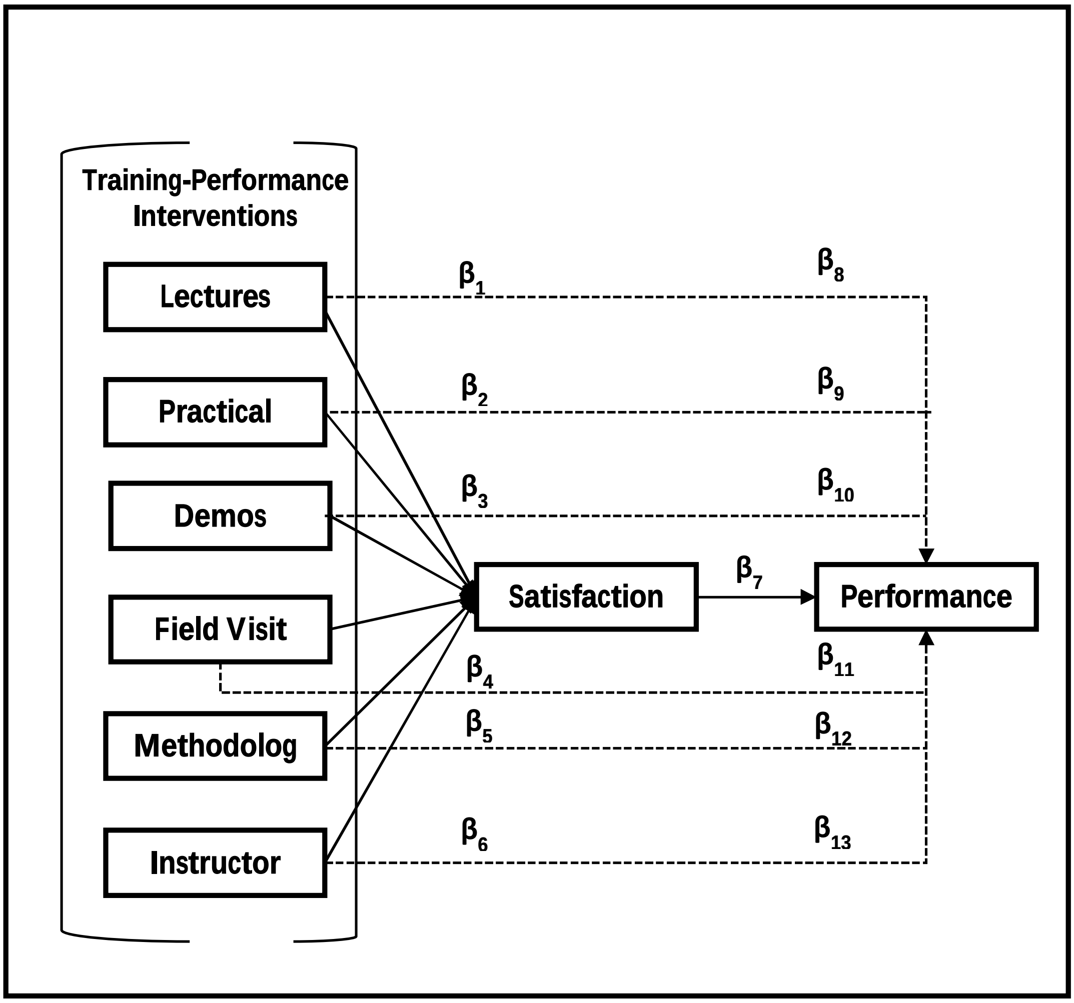

Figure 1. Staff Training and Performance Interventions

4.2 Data Collection

Sample Size: The research sample size is of 200 participants who attended the training program spread over three years across India from agricultural research sector institutes.

Table. 2 Demography of research sample

Response	Frequency	Percent
Male	140	70
Female	60	30
Total	200	100

Table 3. Sample description

Age Group	Sample size
20-29	30
30-34	68
35-39	70
>40	32

4.3 Research instrument

The *research instrument used* for the survey is a structured undisguised questionnaire – a main source for the primary data collection. Secondary data was collected from various published books, web sites & records pertaining to the topic. The training evaluation questionnaire was divided two sections – in the first section, background information/personal details of the respondent were collected. The Section-II of questionnaire was used to collect the information on six independent variables and a dependent variable, the training program effectiveness. This part contains 64Items, related to Topic specific independent factors – Knowledge, Practical. Course Delivery, Field Visit, Methodology, Instructor, Course Content, Length of Course, Overall Satisfaction and Performance. The respondents were asked to choose the most appropriate 'top-of-the-mind' response for each statement based on their post-training judgment.

4.4 Data analysis

Methods of data analysis: In our empirical investigation we have applied statistical techniques to analyse the data for drawing inductive inferences from our research data. To ensure the data integrity the authors have carried out necessary and appropriate analysis using relevant methods on our findings. The descriptive statistics are used to summarise the data and to investigate the survey questionnaire, formulating the hypotheses the inferential statistics were employed. To measure the central tendency such as means, variance and standard deviation we used the dispersion methods.

Reliability methods: To measure the internal consistency reliability of our research instrument, the survey questionnaire and to maintain similar and consistent results for different items with the same research instrument, we used the reliability methods Spearman Brown split-half reliability static where items are randomly divided the items into two groups. After administering the questionnaire to a group of people the total score each divided group was calculated to estimate the correlation between the total scores. To further confirm, the reliability of our research instrument we have used the Cronbach's Alpha a mathematically equivalent to the average of all possible split-half estimates[37].The Statistical Analytical System (SAS) was used to measure the central tendency, measures of variability, reliability statistics, correlations, parametric tests and to predict the dependent variable training program effectiveness based on

Reliability test of the questionnaire: The Likert-type scale with items 1-5 was used for the independent dimensions (where 1=Not Enough, 2= Just Enough, 3=Enough, 4=Very Much and 5=Too much) and dependent variable Likert scale was (where 1=Poor, 2=Fair, 3=Good, 4=Very Good and 5=Excellent). The reliability statistic Cronbach's alpha coefficient value was calculated for internal consistency of the instrument, by determining how all items in the instrument related to the total instrument [37]-[39]. This instrument was tested on a pilot group of 40 training participants. They were asked to fill out the 64 Items and requested to select the appropriate answer on 5- point Likert Scale. After analysing their responses from the pilot study with SAS program, the Cronbach's alpha static was found to be 0.80 suggesting a strong internal consistency. Two months later, the same instrument was used with 200participants to collect the responses. Four Items were dropped out from a set of 64Items because of unsatisfactory Cronbach's alpha coefficient values. The overall Cronbach's alpha for the questionnaire with a set of 53 questions was 0.88, and the increase was an effect of dropping the questions with low C-alpha values. The reliability values were presented in the Table 4 which ranged from 0.68 to 0.82 (Table 4.). The Table 4 presents the computed C-Alpha Static and Average Variance Extracted.

Table 4: Cronbach's alpha values for variables used in this study

Sl. No	Variable	Number of Items	C-Alpha Value	Average Variance Extracted
1	Knowledge	6	0.94	0.79
2	Practical	6	0.82	0.97
3	Course Delivery	6	0.91	0.84
4	Field Visit	6	0.93	0.82
5	Methodology	10	0.93	0.71
6	Instructor	5	0.94	0.68
7	Course Content	5	0.87	0.76
8	Length of Course	5	0.94	0.88
9	Overall Satisfaction	5	0.81	0.81
10	Performance	5	0.86	0.71

5. RESULTS

Using SEM techniques, measurement models were first developed for each of 10 factors as listed in Table (1). A total of 60 items comprised of first/initial research instrument (questionnaire) was used for evaluation. The factor loadings of the individual items were measured and some items with poor contributors and unsatisfactory factor loadings were eliminated (factor loading < 0.70 is poor; 0.60 unacceptable). After creating the measurement models for each factor, actual SEM analyses performed integrating all individual model into a single large model. This is needed to fit all the 10 factors with 60 items into a coherent model. Before SEM analysis the data was screened for the analysis and hypothesized model was presented for testing. In this stage specifying specific factors (the boxes and ovals to be tested and the mentioning of specific paths within the model (the arrows). The data was later tested to assess how well the data fit that model. Alternations were made based on the model using conceptual methods and empirical outputs.

From the outputs we eliminated merged the two factors Satisfactory and Performance were merged into one as these factors are highly correlated (r= 0.989) and essentially represent the same factor. After the aggregation nine factors were used are: Knowledge, Practical, Course Delivery, Field VisitMethodology, Instructor, Course Content, Length of Course, Overall Satisfaction & Performance.We continued the evaluations and these models were assessed as poor fit, Root Mean Square Error of Approximation (RMSEA) always to be greater than .10 (.00 to .05 = excellent fit; .05 to .10 = acceptable fit; .10+ = poor fit). We used this data to identify the model with acceptable fit. The Average Variance Extracted the convergent validity.

Firstly, to obtain a model that fit the data well, items with unacceptable loading factor loadings (loadings with < 0.60) were eliminated and we considered only six items. Finally we considered only the seven factors Lectures, Practical, Demos, Field visit, Methodology and Field visits and trainee satisfaction/Performance. (Green oval Figure 2). Overall evaluation Satisfaction/Performance was used as second latent variable. Overall model suggested that Satisfaction served as an indication Performance. This means the other factors influenced the training program validation of the research instrument and the performance to apply the knowledge gained during training to their routine jobs.

Overall, the model presented in Figure 1 demonstrated poor fit based on the Chi-Squared value, $\chi 2$ (200) = 312.60, p< .000, indicating that the specified model and data were significantly different. However, because the degrees of freedom were so large (200) based on the number of potential paths, it was not a good indicator of model fit. However, the Root Mean Square Error of Approximation (RMSEA), Relative Fit Index (RFI), and the Standardized Root Mean Square Residual (SRMR) all suggested acceptable or good fit; RMSEA = .072 (.05 to .10 equals acceptable fit); RFI = .94 (.95 or greater suggests good fit); and SRMR = .044 (.05 or less suggests good fit). In this instance, they would be considered more appropriate fit indices.

Based on our first model results, a final model was developed for the instrument (Figure 1). This model identified a total of 19 items that best contributed to the model:

3 Items for Lectures (ability to link the subject, latest knowhow, communication)
2 Items for Practical (lab space, scope, knowledge and supplies)
3 Items Course Delivery (systematic deliver, time usage, delivery mechanism, coverage, content)

2 items for Field Visit (field experiments, field demos, application, practical understanding)
2 Items for Methodology (goals, quizzes, expectation of students, student alignment)
2 items for Instructor (skills, knowledge, effective interaction)
5 items for performance (increased aptitude, achievement, application of learned knowledge)

After that we have rephrased some items and eliminated 3 items course content, length of course, and overall satisfaction. The model was rerun the out was presented in Figure 1 and the correlations was presented into Table 5, indicating the correlation matrix for indicators of overall performance.

Table 5. Correlation matrix for indicators of Overall Performance (after rephrasing the items)

	Lectures	Practical	Course delivery	Field Visit	Methodology	Instructor	Performance
Lectures	1						
Practical	0.80**	1					
Course Delivery	0.80**	0.78**	1				
Field Visit	0.73**	0.78**	0.80**	1			
Methodology	0.41	0.52	0.62**	0.58	1		
Instructor	0.65**	0.71**	0.73**	0.73**	0.49	1	
Performance	0.49	0.63**	0.65**	0.65**	0.44	0.59	1
**Correlations are significant at prob. <0.01; Source Primary Data							

SEM Results of Refined Instrument

The refined set of items was used to develop a refined instrument to assess Training Performance using the data from 200 participants for SEM analysis. More or less same results were obtained and we have eliminated the Course Contents, Length of Course, Overall Satisfaction (see Figure 2). We have obtained the same poor fit as Chi-Squared analysis suggested, χ^2 (200) = 302.34, p< .000, indicating the specified model and the data were significantly different. Due to the degrees of freedom were so large (200) based on the number of potential paths, it was not a good indicator of model fit. The results of RMSEA = .084 (.05 to .10 equals acceptable fit); RFI = .95 (.95 or greater suggests good fit); and SRMR = .05 (.05 or less suggests good fit) suggested good fit. This indicated that model tested for the refined instrument demonstrated an acceptable fit with the data. The ß values indicated picture along with the arrows. There is a moderate degree of overlap overall performance demonstrated suggesting again that the overall performance factor was relevant. In other words, the factors vary in terms of their degree of empirical overlap, suggesting that some factors are more related than others. Therefore, overall evaluations do not result from the addition of completely independent factors. The correlation matrix after the second elimination presented in Table 6.

Table 6. Correlation matrix for indicators of Overall Performance (final refinement)

	Lectures	Practical	Course Delivery	Field Visit	Methodology	Instructor	Performance
Lectures	1						
Practical	0.79**	1					
Course Delivery	0.82**	0.81**	1				
Field Visit	0.60	0.78**	0.78**	1			
Methodology	0.69**	0.68**	0.66**	0.66**	1		
Instructor	0.62**	0.61**	0.59	0.59	0.52	1	
Performance	0.64**	0.65**	0.72**	0.73**	0.61**	0.69**	1
**Correlations are significant at prob. <0.01; Source Primary Data							

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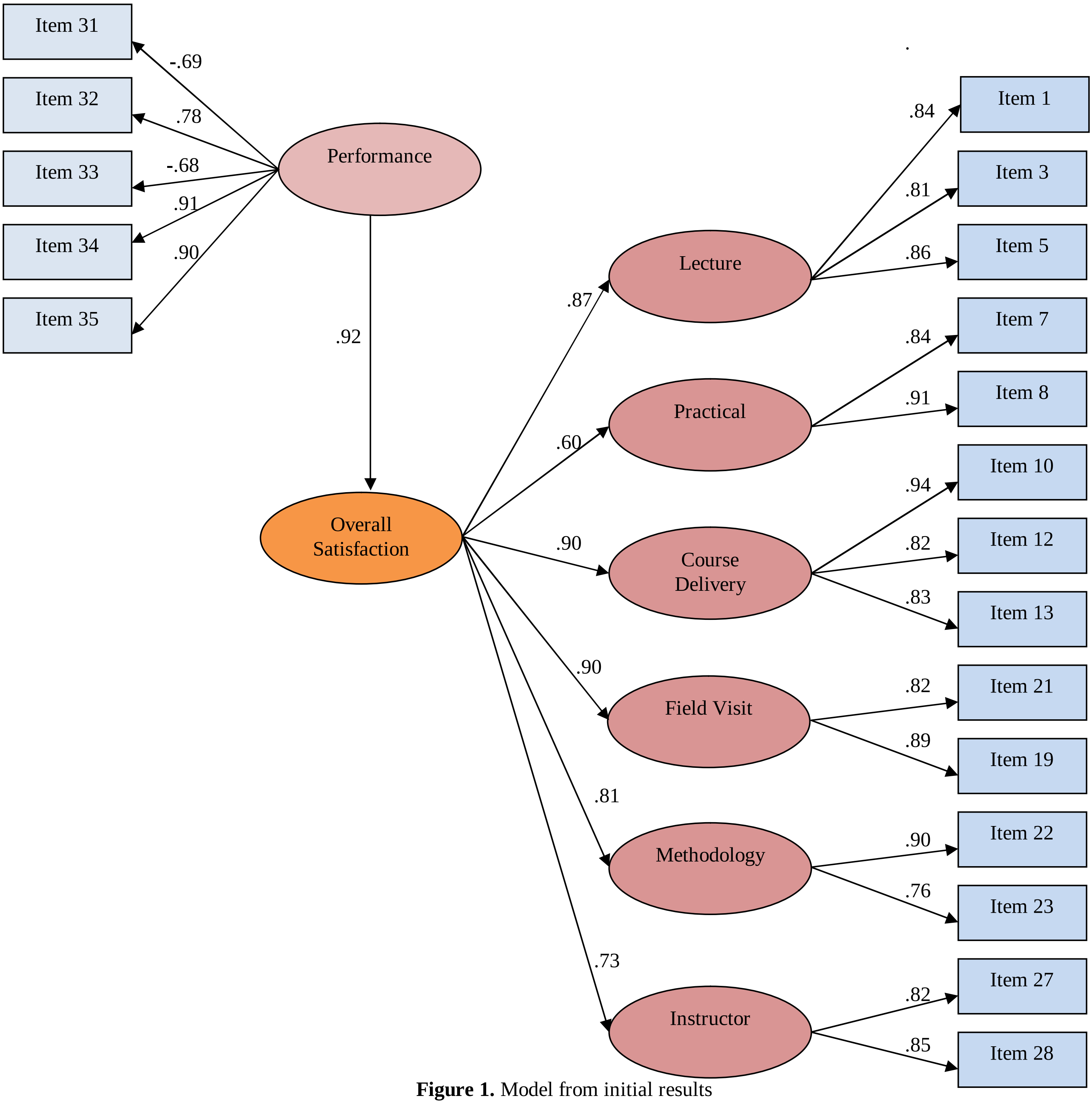

Figure 1. Model from initial results

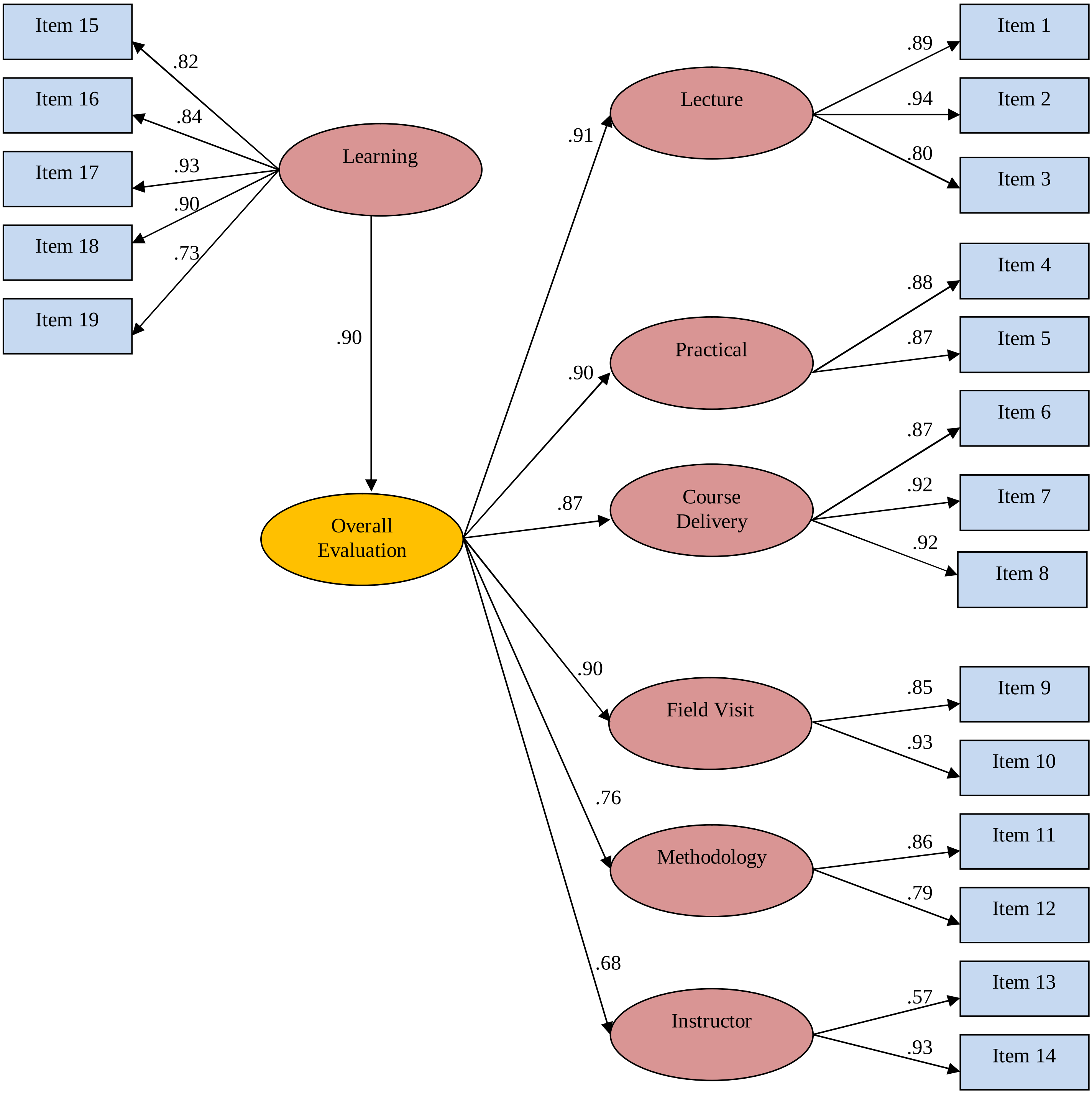

Figure 2. Replication of Likert-Scale Model.

7. CONCLUSIONS

From the models presented and correlation matrices some specific comparisons can be made between the two models and the results will be used to see the overall picture how well the second replicated the results of first model. It was observed that the RMSEA values differed for the first and the second models (.072 for model 1 as compared to .084 for model 2), this difference was not significantly different, χ^2 (30) = 4.45, p = 1.00, suggesting that the two models were statistically equivalent in terms of their fit with the data. Suggesting the consistency among the two models.

It was observed the path from Overall performance to the Methods factor was significantly different ($\Delta\beta$ = .37, p< .01). All other paths were found to be statistically the same. This difference may have resulted because the eliminated of four factors excluded in the refined instrument. This means the interrelationships among the factors changed by eliminating factors, and might have resulted in the significantly different beta weight. However, given the overwhelming similarities between the beta weights from models 1 and 2 (six of seven were statistically the same), evidence for consistency was obtained by examining the beta weights.

Finally, an analysis of the correlation matrices was conducted. The correlations for Table 1 and 4 were compared (See Table 5). A critical value of .01 was used to compare the large number of correlations. From the Table 5, although correlations between the two sets of data varied somewhat, only two of the bivariate correlations changed significantly from the first analysis to the second analysis, and both correlations again involved the Methodology factor. In the second analysis, Methods was significantly more correlated with the Practical and Course Delivery. It is very difficult to explain the reasons for difference because of large variations and as there was substantial consistency in the correlations when comparing the first analysis to the second analysis the correlations are statistically the same.

Therefore, based on tests of the model in Figure 2, it can be concluded that:

1. The data collected using the revised instrument demonstrated a good fit with the specified model;
2. The Overall Performance of participants in training result from the additive influence of their evaluations of Lectures, practical, field visits, methodology, demos, course delivery
3. The amount of learning and planned action that occurs influences overall performance training activity.

Finally, based on the comparisons between the initial and final SEM analyses, it can be concluded that:

1. The results were generally consistent from the first to the second analysis; and
2. Although there were a few discrepancies, the results of the second analysis provide validation for the refined instrument.

Table 7. Differences in correlations between Table 5 and Table 6

	Lectures	Practical	Course Delivery	Field Visit	Methodology	Instructor	Performance
Lectures	1						
Practical	-0.01	1					
Course Delivery	0.02	0.03	1				
Field Visit	-0.13	0.00	-0.02	1			
Methodology	0.28**	0.16**	0.04	-0.08	1		
Instructor	-0.03	0.14	-0.14	-0.14	0.03	1	
Performance	0.15**	0.02	0.07	0.08	0.17**	0.10	1

**Correlations are significant at prob. <0.01; Source Primary Data

Given these conclusions, the VA may consider its instrument to be a valid tool for evaluating educational activities within the VA system. In practical terms, the instrument would be able to provide three specific types of data:

- An average score for each factor, so that trainers can assess different aspects of their educational activities;
- An overall evaluation score (the mean of all six factor scores that represent Overall Evaluations), so that educational activities can be evaluated easily and efficiently; and
- A learning and planned action score to help trainers evaluate participant perceptions regarding knowledge and skill gain and its applicability to the job.

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