INTRODUCTION

The present research applied information integration theory (Anderson, 1981) to achievement judgments by school teachers. School teachers contribute directly to the development of human resources in any society. A study of their causal conception of what makes a student successful, therefore, has a great practical interest. It is surprising, however, that Anderson's two volumes, Foundations of information integration theory (1981) and Methods of information integration theory (1982) mention no study of cognitive algebra in school teachers. Since cognitive algebra reflects on the process underlying judgment, the present dissertation reports how school teachers process and integrate information about motivation and ability of students in prediction of their performance.

The following poem represents the general attitude of school teachers toward achievement:

Do your best, your very best,
And do it every day.
Little boys and little girls,
That is the wisest way.

Whatever work comes to your hand,
At home, or at your school,
Do your best with right good will;
It is a golden rule.

For he who always does his best,
His best will better grow;
But he who shirks or slight his task,
Lets all the better go.
What if your lessons should be hard?
You need not yield to sorrow,
For he who bravely works today,
His tasks grow bright tomorrow.

(Hickson, 1981)

The theme that runs across the entire poem is "do your best and try again and again". But trying by itself cannot make anyone achieve anything. As Heider (1958) rightly notes,

The personal constituents, namely, power (ability) and trying (effort) are related as a multiplicative combination, since the effective personal force is zero, if either of them is zero. For instance, if a person has the ability but does not try at all, he will make no progress toward the goal (p. 83).

Heider's idea implies that motivation or trying will be more effective with a person of high than low ability. The multiplying rule precisely entails such an idea. It is thus commonly held that

\[
\text{Performance} = \text{Motivation} \times \text{Ability}. \tag{1}
\]

Test of the above model requires that the stimulus values of motivation and ability be at least on the interval scale. Similarly, the response measure be an interval scale. Exact test of Heider's model was held back for want of measurement capability. Functional measurement (Anderson, 1976, 1981, 1982) provides such a measurement capability. It is possible, therefore, to translate the above verbal assertion into its exact mathematical form.

Over a decade, integration rule underlying prediction of performance from information about motivation and ability
has been a subject of controversy. Evidence for multiplying, adding, and averaging rules has been obtained, depending upon age and culture of subjects as well as upon difficulty and nature of task.

REVIEW OF THE LITERATURE

Twelve reports on prediction of performance from information about motivation and ability are currently available. These studies are briefly reviewed in their chronological order.

Anderson and Butzin (1974). Anderson and Butzin provided the first test of Heider's proposal, Performance = Motivation x Ability. American college students received information about motivation and ability of applicants to graduate school and athletes trying out for college track, and predicted their performance in their respective fields. The factorial plot of Motivation x Ability effect had the hypothesized linear fan pattern. The authors claimed, therefore, that prediction of performance followed the multiplying rule.

Kun, Parsons and Ruble (1974). In a series of three experiments, Kun et al studied prediction of performance on puzzles on the basis of effort and ability of stimulus persons, using the methods of information integration theory. They found evidence for the linear fan pattern, beginning Standard II. The younger children had the parallelism pattern. Kun et al concluded, therefore, that fan pattern evolves out of parallelism pattern.
Singh, Gupta, and Dalal (1979). Singh et al reasoned that the linear fan pattern obtained by Anderson and Butzin (1974) and by Kun et al. (1974) can be accounted for by both the multiplying and differential-weight averaging rules. If lower values of motivation/or ability had greater weight, then the averaging model could produce an approximate linear fan pattern (Anderson, 1971, p. 185).

A series of three experiments were performed on college students in India to test these two rival interpretations. Subjects predicted the exam performance from motivation and ability or any one of the two, that is, motivation alone or ability alone.

Singh et al obtained three principal results. First, the factorial plot of the Motivation x Ability effect had the parallelism or converging pattern, not the diverging pattern obtained in American studies. Second, judgments based on ability alone or motivation alone had slope steeper than judgment based on both ability and motivation information. Since the averaging rule predicts steeper slope for curve based on less information (Anderson, 1981, pp. 58-64, 113-128), it was concluded that prediction of exam performance obeys an averaging rule in India.

Finally, subjects had imputed some value for the missing information when they were asked to render their judgment on the basis of motivation alone or ability alone. Singh et al,
therefore, demonstrated not only operation in imputation in prediction of performance but also showed how the problems associated with imputations can be avoided in model analysis.

As the two American studies (Anderson & Butzin, 1974; Kun et al, 1974) had linear fan pattern but studies of Singh et al had near-parallelism, the hypothesis of the difference between America and India seemed reasonable. The multiplying rule implies that motivation will be more effective with persons of high than low ability. In contrast, the equal weight averaging implies that the motivation will be equally effective with persons of high and low ability.

Surber (1980). Surber asked subjects from Kindergarten, Standard III, Standard V, and college to predict the performance of a hypothetical participant in a weight-lifting contest. Her results were similar to those of Kun et al (1974). The factorial plot of the Motivation x Ability effect in the Kindergarten children had the parallelism pattern but all the other three groups of subjects had the linear fan pattern.

Surber also used distinguishing test between multiplying and averaging rules just as Singh et al did. She had asked her subjects to predict the performance on the basis of information about motivation alone or ability alone. The multiplicative interpretation was preferable only at the level of college students. Judgments by other groups of subjects were represented by the averaging rule. Surber's multiplicative interpretation of adult data was based on the assumption that subjects imputed a single fixed value for missing information when they
were asked to give their judgment on the basis of only one piece of information.

Anderson (1981). The distinguishing test between alternative rules used by Singh et al. (1979) and Surber (1980) cannot always be expected to yield clear result if subjects impute value for missing information. As imputations are quite common in cognitive algebra (Singh, in press), Anderson employed new distinguishing tests between multiplying and averaging rules. These tests did not involve missing information at all. The task involved prediction of performance of applicants to graduate school, and the results were much the same as in Anderson and Butzin (1974).

Gupta and Singh (1981). This was a developmental study of the cultural-difference hypothesis proposed by Singh et al (1979). Subjects were from Standard II, IV, VI, and VIII of a school, and adults from college. The designs were patterned after Experiment 3 of Singh et al (1979).

Results from this study provided further support for the cultural difference hypothesis. There was a prevailing pattern of near-parallelism in all the five groups of subjects. In addition, the single-cue curve crossed over the two-cue curves, and the two-cue curves crossed over the three-cue curves. On this basis, the authors concluded that prediction of exam performance indeed obeys an averaging rule in India.
Surber (1981a). In a study of college students, Surber manipulated motivation, reliability of motivation information, ability, and reliability of ability information and tested the contradictory predictions of the multiplying and averaging models. If the averaging rule holds, then judgment of performance should be

\[
\text{Performance} = \frac{w_M M + w_A A + w_O I_O}{w_M + w_A + w_O},
\]

(2)

where \(M\), \(A\), and \(I_O\) are the scale values of motivation, ability, and initial opinion and \(w_M\), \(w_A\), and \(w_O\) are their relative weights. But if the multiplying rule holds, then

\[
\text{Performance} = w_M M \times w_A A.
\]

(3)


However, the two models make sharply contradictory predictions about the relationship between reliability of information of one type and effectiveness of information of another type. The averaging model of Equation 2 predicts that as the reliability of information of one type would increase, the relative weight and the relative effect of the information of another type would decrease (Surber, 1981a). If motivation and ability are multiplicated, however, then an increase in weight of information of one type
would also increase the effect of information of another type (Singh, in press).

Surber obtained evidence for the prediction of averaging rule and against the multiplying rule. More importantly, she found the evidence for a slightly converging pattern in the Motivation x Ability just as in Indian studies (Gupta & Singh, 1981; Singh et al, 1979).

This failure of linear fan pattern was not attributable to task-simplification, for the relationship between weight and scale value of each factor was clearly multiplicative. In her experiment, Surber described the exam to have moderate difficulty. Accordingly, she suggested that difficulty of task may be a better interpretation than the cultural-difference hypothesis for the converging, parallelism, and diverging patterns in the Motivation x Ability effect.

Surber (1981b). Surber tested her task-difficulty hypothesis by describing college exam as easy, moderately difficult, and very difficult. Consistent with her hypothesis, she found that the factorial plot of the Motivation x Ability effect yields converging, parallelism, and diverging pattern for exam described as easy, moderately difficult, and very difficult, respectively.

This experiment had also employed single-cue discriptions just as in Singh et al (1979) and Surber (1980). Single-cue curves had clearly crossed over the two-cue curves at each of
the three levels of exam-difficulty. So, she claimed support for the averaging model and rejected the multiplying model.

Singh and Bhargava (1982 a). In a series of six experiments, Singh and Bhargava tested three hypotheses, namely, cultural difference, task difficulty, and imputation of missing information in prediction of exam performance. Subjects were school students, postgraduate students of management, college lecturers, and executive engineers in the State of Gujarat. The experiments had manipulation of exam difficulty, reliability of information, and missing information. The distinguishing tests between alternative rules were based on the logic of two-operation model (Singh, in press). The motivation information came from three independent sources and they were paired with ability information. Each of the three motivation cues were also paired with the motivation-cue separately. The authors tested two alternative models, namely, the compound averaging-multiplying model,

\[
\text{Performance} = (\text{Motivation-1} + \text{Motivation-2} + \text{Motivation-3}) \times \text{Ability},
\]

and four-term averaging model,

\[
\text{Performance} = \text{Motivation-1} + \text{Motivation-2} + \text{Motivation-3} + \text{Ability}.
\]

The compound averaging-multiplying model predicted linear-fan pattern in Motivation x Ability graphs. The four-term averaging model, however, predicted parallelism pattern.
The critical discrimination between multiplying and averaging rule comes from the pattern in the factorial plot of Motivation x Ability data from the four-cue and two-cue design. The multiplying model predicted a common linear fan pattern but the averaging model predicted a steeper slope for two-cue curve than for four-cue curve.

The same logic was extended by manipulating set size of motivation information. In one experiment, one and three pieces of motivation information were paired with an ability information. It was reasoned that one-term averaging rule would produce steeper slope for set-size 1 than for set-size 3 in the combined factorial plot of Motivation x Ability. However, if the multiplying rule is true, then

\[
\text{Performance} = \left[ \frac{kwM + (1-w)M_o}{kw + (1-w)} \right] x w_A A. \tag{6}
\]

where \(M\), \(M_o\) and \(A\) are motivation, initial opinion of motivation, and ability, \(w\), \((1-w)\), and \(w_A\) are weights of motivation, initial opinion of motivation, and ability, and \(k\) is the number of similar pieces of motivation information.

This series of experiments invariably obtained evidence for the parallelism pattern in the Motivation x Ability effect as predicted by the cultural-difference hypothesis. The manipulation of exam difficulty did not alter the parallelism pattern at all contrary to the task difficulty hypothesis (Surber, 1981 b). Singh and Bhargava (1982 a) noted, therefore, that prediction of exam performance is indeed susceptible to cultural factors.
The importance of cultural factors in prediction of exam performance was also suggested by the difference in results obtained with the manipulation of reliability information. Subjects did not follow the averaging model (i.e., Equation 2) tested by Surber (1981 a). Instead, they obeyed a compound averaging-adding model,

\[
\frac{w_0}{w_0 + w} \left( \frac{m_0 + w m}{w_0 + w} \right) + \frac{u_0}{u_0 + u} \left( \frac{a_0 + u a}{u_0 + u} \right),
\]

(7)

where \(M\) and \(A\) refer to motivation and ability, \(w\) and \(u\) refer to their weights, \(M_0\) and \(A_0\) refer to initial opinion of motivation and ability, and \(w_0\) and \(u_0\) refer to their weights.

This equation implies that reliability of information affects the corresponding initial opinion, and that subjects have two separate initial opinions. Manipulation of reliability information thus turned out to be more useful in diagnosis of processing flow than in diagnosis of cognitive algebra underlying prediction of exam performance.

The experiment which had manipulation of set-size of motivation information also had evidence for compound averaging-adding model. The judgments conformed to the following model,

\[
\text{Performance} = \frac{w M + (1-w) M_0}{w + (1-w)} + w A.
\]

(8)
A developmental study further indicated that adding rule is used by the postgraduate students of management, high school and college students followed the averaging rule.

Three of these six experiments had manipulation of missing information, and they all obtained clear evidence for imputation about missing information. Sometimes a missing ability information was imputed a constant value; other times the missing value was a direct function of the given value of information. Similar tendency was noted with the value of missing motivation information. This asymmetry in imputation rule was eliminated by instructing subject to develop their "own strategy of dealing with the missing information".

This report by Singh and Bhargava raised several important issues for cross-cultural research. Subjects from India and United States differ not only in their cognitive algebra but also in their processing of information. It is possible to detect these differences by identification of cognitive algebra underlying judgment.

Singh and Bhargava (1982 b). In a series of four experiments, Singh and Bhargava presented information about motivation, ability and opportunity available to stimulus person and asked postgraduate students of management to predict life performance of so-described high school students. In all the four experiments, the factorial plot of the Motivation x Ability effect had the linear fan pattern. Distinguishing tests based
on the logic of two-operation model (Singh, in press) further disclosed that fan pattern was caused by multiplying rule and not by differential-weight averaging rule.

Experiments which had manipulation of information reliability again yielded evidence for two separate initial opinions, one about motivation and other about ability. It is remarkable that both the exam performance task (Singh and Bhargava, 1982 a) and the life performance tasks yielded evidence for two initial opinions, even though the underlying cognitive algebra was adding for exam performance and multiplying for life performance.

Bhargava (1983). In his doctoral research, Bhargava traced developmental changes in integration rules for prediction of life performance. His subjects were students of Standards V, VII, IX and XI of a school, first year students of a college, and postgraduate students of management. The experimental task was patterned after that in Experiment 4 by Singh and Bhargava (1982 b). The results supported the hypothesis of change in integration rule: The post-graduate students followed the multiplying rule, whereas others followed the averaging rule.

Because the post-graduate students followed the multiplying rule in prediction of life performance but adding rule in prediction of exam performance, Bhargava suggested a hypothesis of nature of task. He speculated that Indian subjects follow the averaging rule up to the age of twenty, and that rules change as a function of nature of task later on. Bhargava
demonstrated that the same management students who predicted life performance of students by multiplying rule predicted managerial performance of trainees according to an adding rule. In this way, Bhargava presented preliminary data on the plausibility of the hypothesis of nature of task as a determinant of cognitive algebra of task performance.

Srivastava (1984). In this comprehensive developmental study of cognitive algebra, Srivastava used three tasks, namely, exam performance, puzzle competition, and music competition. Subjects were of 4 to 16 years of age.

Srivastava provided the most rigorous test of the hypothesis of nature of task. She argued that multiplying rule can be obtained at early age if the task demands so. Bhargava's (1983) assertion that multiplying rule develops around the age of 20 in India would thus be restricted to life performance task.

The results obtained by Srivastava basically supported her position. Prediction of exam performance yielded no evidence for developmental trend: All subjects followed the averaging rule. But prediction of performance in music competition yielded a clear-cut developmental trend: Children from Kindergarten to Standard VI obeyed the multiplying rule; children of Standards VIII and XI obeyed an adding rule.
On the basis of her results and the previous studies, Srivastava noted:

'If we carefully consider results obtained from studies of exam performance (Gupta & Singh, 1981; Singh & Bhargava, 1982 a; Singh et al, 1979 a), life performance (Bhargava 1983; Singh & Bhargava, 1982 b), and competition performance of the present research, we now find that all these three tasks were handled in much the same way by high school and undergraduate students. All the three tasks yield a pattern of parallelism. This means that this is perhaps a period of optimism and idealism in India, for these students believe that effort or trying will be equally effective with persons of low and high ability. In other words, each person regardless of his or her ability has equal opportunity to improve upon his or her lot. This outlook certainly reflects on the equalitarian attitude of this young group of people in India (pp. 108-109).

Comments

The studies reviewed above suggest that cognitive algebra of task performance is much more complex than what has been believed to be (Heider, 1958). The integration rules for prediction of task performance depend upon age and culture of subjects as well as on difficulty and nature of task. None of these factors by itself can fully account for the existing data on prediction of performance. Therefore, further research is needed to bring coherence in extant literature on social cognition of task performance.

The Present Research

The present research tested the hypothesis that the role people play in their life determines their causal schema. In other words, people playing a similar role can be expected to
follow the same integration rule in prediction of performance over a wide variety of tasks.

The rationale for the above hypothesis comes from the role theory (Sarbin & Allen, 1968/1975). As is clear from the following quotation,

... occupancy of a social position entails the adoption of all components of role expectations, cognitive as well as motoric and expressive, beliefs and opinions associated with a role are as much integral parts of a role as the motoric components. To validate occupancy of a new position one must engage in appropriate behavior, which includes not only overt motor performances but also the holding of certain beliefs and opinions. To validate occupancy of a position successfully requires satisfaction of all components of role expectations. According to this view, opinions and beliefs appropriate at the same pace as new overt behavior (pp. 555-556).

A good illustration of the effect of role on attitudes is provided in the widely cited study by Lieberman (1956). Factory workers indicated their attitudes towards labor union and management. During the ensuing year some workers were promoted to foreman, others to union leaders. Upon reassessment, workers had more favorable attitudes toward management, but the new union leaders had less favorable attitudes toward management. Thus, the men endorsed attitude congruent with their newly acquired roles.

If teaching children in school demands new role expectations, then teachers can be expected to display uniformity in their causal conception of performance. Therefore, school
Teachers were asked to predict exam performance, competition performance, and life performance of high school students. Details of the four experiments which were performed are described in Chapters 2-5.