Human learning and performance is a very complex phenomenon. It has been so fascinating and challenging an area that it invited the attention of many educationists, social scientists and psychologists. They have been pondering and experimenting on learning since long. One of the chief concerns of these philosophers and psychologists has been to understand the nature and dynamics of learning process so as to optimize learning.

Hilgard (1958) defined learning as, "The process by which an activity originates or is changed through reacting to an encountered situation, provided that the characteristics of the change in activity cannot be explained on the basis of native response-tendencies, maturation or temporary states of the organism (e.g. fatigue or drugs, etc)". Gagne (1977) defined learning as, "A change in human disposition or capability, which persists over a period of time and which is not simply ascribable to process of growth". Thus, it is clear that learning manifests itself as a change or modification in behaviour brought about not only through physical maturity but also through reacting to an encountered learning situation. The change may be and often is, an increased capability for some type of performance.

There is, however, some controversy as to how the change takes place in the learning situation. Many theories
have been put forth to explain the process of learning. The numerous approaches to learning can be classified into two general approaches:

(i) S-R connectionist or bond theories, include Trial and Error theory (Thorndike, 1898); Classical Conditioning (Pavlov, 1927); Operant Conditioning (Skinner, 1938); and Drive Reduction theory (Hull, 1943).

(ii) Insightful theories include Gestalt or insight theory (Kohler, 1929; Koffka, 1929; and Wertheimer, 1945); and field theory (Lewin, 1946).

Various schools of psychology have used different approaches to explain learning process. However, these two approaches are not mutually exclusive because many psychologists draw upon both, in their effort to understand the learning process (Sarason, 1964). It is a broad assumption that change takes place in behaviour by the building up of associations. These associations or bonds are formed through different processes. While Watson (1914, 1925) analysed behaviour in terms of S-R units called reflexes, Hull (1943) analysed the same in terms of S-R units called habits and Skinner (1938), in terms of the relationship between responses and reinforcement contingencies in the environment. The field and insightful theories emphasize not the mechanical S-R sequence, but the context, in which the stimulus occurs and the insight derived when the relationship between stimulus and context is seen by the learner.
ROLE OF REINFORCEMENT IN LEARNING

Another common assumption is that of hedonism (Pervin, 1970) which is manifested in Thorndike's (1898) law of effect. This law brings into focus the role of reinforcement in learning. The role of reinforcer, in form of reward or punishment or verbal approval or disapproval or some physically tangible object, cannot be denied whether it is S-R bond formation or insightful learning. Almost all the theories of learning recognised the role of reinforcement in learning. Steigman and Stevenson (1960) have shown that reinforcement in the form of rewards not only encourages learning but also develops better feelings among the learners. Sarason (1966) views that change in response is often the result of some reinforcement. Dececco and Crawford (1977) emphasize the role of reinforcement by defining learning "as a relative permanent change in behaviour as a result of reinforced practice". In Thorndike's (1898) 'Trial and Error' learning, the presence of food (fish) in front of the hungry cat worked as a reinforcement. Had there been no fish, the hungry cat (in the cage) would not have vigorously attempted to come out of the cage and the bond between pressing of the button of the lever and coming out of the cage would not have strengthened.

Similarly in Pavlovian (1927) classical conditioning too, the presence of food (powdered meat) along with the conditioned stimulus, i.e., 'bell' made the dog to respond (salivate). If the conditioned stimulus is presented alone,
conditioning does not occur.

The role of reinforcement is somewhat different in instrumental conditioning where, the response under study is always one that has an initial low frequency of occurrence. The experimental problem is to increase the probability with which that response will occur. In Skinner's experiment (1938), the hungry rat used to get the pellet of food on pressing the lever, which acted as reinforcer as it motivated the rat to press the lever again and again.

Hull (1943) explained learning on the basis of drive reduction. These drives are assumed to have motivational properties. When drives are satisfied or needs are met, a reduction in activity results, which acts as reinforcement by helping the organism to learn about a particular bond or response.

In the insightful learning too, the 'banana' acted as reinforcement to the chimpanze which motivated him to place the boxes under the bananas or to fix up the sticks together in order to get at them.

Mohan (1977) maintained that, "whether we talk of S-R connectionists or insightful learning, we are always admitting the role of some agency, through which goal is being reached, need fulfilled, gratification obtained". That agency is motivation in the form of some reinforcement. Motivation is very complex and difficult to study. Learning in animals is motivated, almost entirely, by physiological motives, where the reinforcement is in the form of tangible and physical nature.
But in human learning the reinforcement need not only be of some tangible nature. According to Gupta (1978), "It may assume the form of some verbal approval or disapproval, praise or blame or even simple statement of the actual performance." Any such reinforcement is an important motivating agent which helps in improving and sustaining efficient learning. One such potent agent of reinforcement is known as 'knowledge of results' (KR), which, according to Madan and Dey (1964) means, "The information which is available to the subject about the success or failure in the course of task performance, which in turn, helps in evaluating the response just made or previously made. KR helps the performer to discriminate along a sensory continuum in a given direction, transfer fine responses adjustment from one situation to another and thus increase the potential to make a more nearly correct response". Ammons (1956), too, emphasized the motivational role of KR in facilitating learning and performance. Locke (1967) also pointed out that reinforcement in the form of reward, punishment or KR enables the subject to make his responses, goal directed and eliminate wrong responses.

There is a consensus that KR facilitates performance. KR is sometimes referred as feedback. Annet (1964) has described two types of feedback i.e. 'Intrinsic' and 'Extrinsic'. The former refers to the information, the subject obtains through his own action while the latter is the information, the experimenter gives to the subject about the latter's performance. Mohan (1977) described that the intrinsic KR may be limited to the proprioceptive perception.
associated with the execution of the response whereas the extrinsic KR is additional information about the results supplied to the subject to direct his behaviour towards goal.

The facilitative effect of KR upon learning and performance is now an established fact. But how this improvement in performance takes place, has been the main concern of psychologists. Mohan (1977), while emphasizing the directional and motivational role of KR, reported that this improvement takes place in two ways:

(a) By informing the subject about the type, extent and direction of his errors, the subject can generally use such information to correct his errors or improve his method of performing the task;

(b) By motivating the individual to persist and put in more efforts. Annet (1969) explained KR in terms of incentive and reinforcement, incentive as 'drive inducing' and reinforcement as 'drive reducing'. The knowledge of results, according to Gupta (1978), ignites a desire to reach the new situation and it can uphold the motivational aspect of KR.

**PERFORMANCE ON DIFFERENT TASKS AND KR**

The facilitative effect of KR upon learning has been observed with a variety of tasks. Mohan (1969) while reviewing the facilitative effects of KR, grouped the tasks used so far, ranging all the way from motor to psychomotor, and to mental tasks.
1. **KR and Psychomotor Performance**

The effect of KR upon different psychomotor tasks has been discussed under following subheads:

(i) **Line Drawing and KR**: Thorndike (1931), Trowbridge and Cason (1932), Greenspoon and Foreman (1956), McGuigan (1959), Mohan (1969), Singh and Thakur (1972), Mohan (1973), Gupta (1978) and Mohan, Gupta and Sharma (1985) reported a marked improvement in estimation of different lengths of line as a function of KR. Singh and Thakur (1972) observed that the KR favourably affected performance and this effectiveness was independent of the length of a line.

(ii) **Estimation of Time and KR**: In the area of time estimation and the effect of KR, Waters (1933), Madan and Dey (1964), Mohan (1969) using 12 seconds and 7 seconds for time estimation, had found that KR leads to improvement in performance. Mohan and Sekhon (1972) asked their Ss to estimate the durations of 3, 5, 7 and 9 seconds. Marked improvement in estimation was noted after the introduction of KR, the acquisition rates ranged from 43.4% to 57.4%. Allen and Clark (1981) reported that their KR group, in addition to increased accuracy and consistency of judgements, showed a decreasing Weber's fraction during the estimation phase while the Weber's fraction for the no KR group increased in time estimation. Mohan and Deol (1983), too, reported a marked improvement in estimation of 7 seconds of time.
(iii) **Estimation of Weight and KR** : In estimation of 40 grams of weight, Mohan and Damral (1971) and Mohan and Gupta (1972, 1984) reported marked improvement in the acquisition of efficiency when the KR was given. The acquisition rates ranged from 24% to 56%.

(iv) **Reaction Time and KR** : With reaction time, McCormack et al. (1962, 1963), Church and Camp (1965), Mohan (1969a), Mohan and Mann (1970) reported that, with KR the reaction time improved significantly. Strang (1983) reported that RT performance deterioration across trials in the KR group was significantly less severe than in no KR group.

(v) **Some Other Psychomotor Tasks and KR** : The facilitative effect of KR has also been observed on certain other psychomotor tasks. Peterson (1948) reported 11% gain in the performance of KR group in the letter cancellation test. Phillips et al. (1980) studied the relative effectiveness of different forms of computer assisted instruction in teaching a psychomotor task. They reported the results in favour of the computerized instruction in comparison with the control teaching procedure. Bach et al. (1980) also reported a significant effect of instructions and practice in feed back systems and maximal channel capacity of the motor systems in a Mitts taping task. Baez (1983) reported the strong dependence of 5 year old children on feedback to control their movement.
2. **Perceptual Tasks and KR**

The facilitative effect of KR has also been observed with regard to some perceptual tasks. Sen and Helode (1971) reported marked decrement in the extent of Muller Lyer Illusion after the introduction of KR. Mohan and Malhotra (1974) while studying the effect of KR on tone discrimination task, reported significant improvement in performance under KR condition. Camus (1981) reported that the KR group gave more correct judgements than no KR group in a numerosity evaluation task.

3. **Vigilance Tasks and KR**

Numerous vigilance tasks such as depressing microswitch, detection of signals, tone discrimination were experimented upon by Lorge and Thordike (1935), Elwell and Grindley (1938, 1939), Hobbs (1947); McCormack (1959); Raymond et al. (1962) and Adams and Humes (1963). All these investigators have reported the superiority of KR group over no KR group. McCormack (1959) asked his Ss to depress the microswitch, as fast as possible, on seeing a light. He reported that response time increased significantly throughout the duration of the task, this increase was more pronounced under no KR condition, than under KR condition. Raymond et al. (1962) while experimenting upon the detection of a periodic interruption of continuous light source reported the significant improvement in performance when reward and KR was given. Huntermark and Wittee (1980) reported an overall vigilance decrement across
the 48 minute watch of the three independent variables after the introduction of evaluative instruction or KR about their performance. Holden and Corrigan (1982) reported that their subjects remained closer to target in feedback condition than under no feedback condition.

4. **Mental Tasks and KR**

Certain investigators have reported that KR facilitates the performance on mental tasks. Book and Norvelle (1922) reported superior performance of children on some mental tasks like writing legible 'a', crossing letters, mental multiplications and substituting symbols when KR was given. Angell (1949) and Paige (1966) reported better performance on chemistry quiz results when KR was given. Mohan and Kumar (1973) on backward alphabet writing, Sen and Ganpat (1973) on serial learning and Mohan and Dhingra (1984) on paired associate learning, reported significant improvement in performance after the introduction of KR.

The above mentioned studies have consistently reported the facilitative effect of KR irrespective of tasks used.

**APPLICATION OF KR IN VARIOUS FIELDS**

The facilitative role of KR is not only a laboratory phenomena, but is also applicable in actual life situations. It has already made its mark as an important constituent of the learning process in different spheres of life. Some of the important areas which have manifested the facilitative role
of KR in improving human behaviour are:

(a) **Academic Achievement**

The foremost concern of the teacher is to increase the readiness of the students so that they are motivated to optimize and maximize their learning. Various incentives have been suggested by numerous psychologists. However, most of the incentives used in the laboratory do not work much in the classroom setting because biological needs and their gratification do not have much of their meaning in the classroom situations. The behaviour and performance of children may be more governed by the sociogenic needs. The incentive given to the school pupil is quite often inadequate, resulting in under achievements, due to lack of motivation.

Plowman and Stroud (1942) studied the effect of allowing pupils to inspect their corrected test papers and reported that the academic performance improved significantly after the introduction of KR. They found that the KR group did significantly better on the second test. Flock and Saggar (1968), too, supported these findings. Guthrie (1971), Tait et al. (1973), and Coleman (1977) reported significant facilitative effect of KR on the acquisition of algebraic concepts. Bayti (1979), too, reported that KR improved the performance of all the four academic subjects which he used. Joshi and Gakhar (1980), and Hannafin (1982) reported that the systematized feedback group scored significantly higher than the control group on algebraic concept formation and
mathematics proficiency test. Tyszkowa and Leneznerowicz (1984) reported that the cognitive activation condition affected performance only among Ss majoring in languages and those with feedback significantly improved Ss performance. Scriven and Glynn (1984) examined the educational impact of introducing a systematic performance feedback programme for 9 low achieving Ss on prose tasks. They reported that performance with feedback resulted in increased task completion for 7 out of 9 Ss.

Thus KR can be used for making the learning process effective and more meaningful by correcting the errors side by side. Guthrie (1971) viewed that the feedback operates primarily to correct error responses by acting as a strong corrective device. According to Gupta (1978), "The administration of tests becomes meaningless if the Ss are not given immediate KR of where and how they have erred". Usually, the very purpose of evaluation is defeated if the results are declared after much delay. KR gives direction to the learning and at the same time keeps the pupil alert and motivated and ever ready to learn. Through revision of the lesson by providing KR intermittently to the class, teaching becomes more meaningful and keeps the zeal of the students ever high.

(b) Microteaching

Dr. Allen and his group (1963) developed the concept of microteaching at Stanford University. In microteaching, the teaching skill is analyzed into observable specific teaching behaviour. Dosajh (1977) maintained that it is difficult to
tell exactly the number of skills involved in teaching. However, he listed fifteen observable specific teaching behaviour viz. introducing the topic, questioning, dealing with answers, stimulus variations, use of blackboard or chalkboard, handling of teaching aids and other equipments, non verbal cues, reinforcement, use of illustrations and examples, exposition or teaching explanations, encouraging group discussions, planned repetitions and closure. The process of giving feedback to trainees in microteaching, plays an important role in teaching skill which helps the student to evaluate his performance as teacher. Numerous studies have been carried out in our own country and abroad regarding the effectiveness of microteaching in the development of teaching skills.

In India, Tiwari (1967) (In Gupta, 1978) started a project on microteaching in pedagogical institute, Allahabad, where he found the effectiveness of microteaching in schools and training institution. He concluded that tape recording and listening to it afterwards helps the teacher in correcting his mistakes as a function of the knowledge of his performance made available to him. Mc Intyre and Duthie (1972), Marker (1972-73), also concluded in favour of feedback provided in microteaching. Dosajh (1974, 1975, 1977) conducted experiments on microteaching as 'modifier of teaching behaviour' and 'change of teaching self concept', and reported the positive role of microteaching on self teaching process. Morrisen and
Mc Intyre (1975) report that one of the advantages of micro-teaching is that, "provision is made for much fuller and more objective feedback than in other teacher training procedure". Malhotra et al. (1978) studied, "the effect of microteaching on teaching competencies of the teacher trainees' and reported a significant improvement in the overall performance of teaching competence of the teacher. Sharma and Gupta (1978, 1982) reported that all type of feedback resulted in marked improvement in teaching competency of student teachers.

(c) Biofeedback Therapy

Biofeedback therapy is a very recent addition to the psychotherapeutic techniques. In biofeedback, the subject is enabled to control the various parts of the body by giving him knowledge about their functioning. Kamia (1958) taught his subjects to monitor their brain waves through biofeedback. The author asked them to guess the name of the waves they were emitting. Every time they made a correct guess, a feedback in the form of sound was given. It was found that the Ss learned to discriminate Alpha and non Alpha waves and could also control them. After further research in 1968, it was found that the process of biofeedback could be speeded up by sounding the tone alone with Alpha waves.

This technique has initiated new venues for curing various psychosomatic disorders where control of the visceral functions can be learnt. These functions, though under the control of Autonomic nervous system, relate the messages through the Ascending-reticular formation to the brain. As
such, they are voluntary and, hence, can be altered through feedback technique.

The above mentioned studies have established the facilitative role of KR not only in the laboratory learning situations but also in the improvement of human behaviour in almost every life situation.

**PERFORMANCE AFTER THE WITHDRAWAL OF KR (Extinction)**

The facilitative effect of KR in learning situation is an established fact (Ammons, 1956; Mohan, 1977). But there is relative paucity of work reported on the effect of withdrawal of KR on performance, i.e., extinction.

In both classical and operant conditioning the phenomena of extinction takes place i.e., after the establishment of the conditioned response, it may be eliminated by presenting the conditioned stimulus alone after withdrawing reinforcement. This process of extinction is gradual. Thus, if the magnitude of response is used as a measure of the strength of a conditioned response, it will be seen that the first response given during extinction is likely to be of the greatest magnitude, which goes on decreasing gradually on each succeeding trial. Finally, a point is reached where the conditioned stimulus no longer evokes any response whatsoever.

According to Whittaker (1970), the strength of any conditioned response may be measured by determining the number of responses that occur during extinction. Hence, resistance
to extinction in addition to latency, magnitude and probability, provide us with quantitative measures of strength or degree of learning. The phenomena of extinction through withdrawal of reinforcement, occurs in operant conditioning, just as it does in classical conditioning. Quite often, it happens that while the strength of a conditioned response may decrease with each succeeding trial the animal often suddenly begins to respond again. This sudden recurrence of the conditioned response during extinction is called spontaneous recovery, and the curve of extinction, rather than being smooth, is actually punctuated periodically by the recurrence of the conditioned response.

An analogy may be drawn between KR and reinforcement in conditioning. The delivery of both after the execution of a response leads to a subsequent improvement in performance. Extending this analogy further, withdrawal of KR or withholding of reinforcement should lead to the extinction of the learnt response. According to Ammons (1956), "When KR is decreased performance drops. Whether this drop would bring performance back to the same level as that, if this lesser degree of knowledge of performance had obtained all along, cannot be ascertained". In other words after the withholding of KR, efficiency in performance does drop to some extent. But the extent to which this efficiency would drop is difficult to determine. Some of the studies supporting this generalization may be mentioned here.
Thorndike (1931) reported decrement in performance after the cessation of KR after delivering it for 25 trials in a line drawing experiment. Elwell and Grindley (1938) experimented on two hand co-ordination device, where the Ss had to move a spot of light into a given bull's eye, by proper simultaneous manipulation of both the handles of the device. Each subject was provided with KR by means of a score based on how close he came to the bull's eye. They reported a drop in the level of performance of the group that was deprived of KR after a few trials. Macpherson et al. (1949) experimented on target practice with and without KR. The task was to hold down a telegrapher's key for exactly seven seconds. They reported a fairly high increase in the level of accuracy reached with the introduction of KR, but an instant fall in the accuracy after the withdrawal of KR. However, the decrement in performance was not reported to come down to the initial level of performance.

Grant et al. (1950), studied eyelid conditioning and reported that conditioned response was extinguished rapidly after the withdrawal of reinforcement. Grant et al. (1951) reported the same phenomenon on verbal conditioning. The phenomena of extinction was also reported in the studies conducted by Lewis (1956).

In Houston's study (in Ammon's 1956) with padestal sight manipulation test, a decline in ranging scores was observed when the red filter was removed from the target plane. However, the performance of the group after the withdrawal of KR did not drop to the level held by another group which was
never given by KR; Gagne (in Ammon's 1956), and McGuigan (1959) also obtained evidences of extinction on target tracking and aiming experiments after the withdrawal of KR.

Goldstein and Rittenhouse (1954) studied the effect of KR upon gunnery skill with the pedestal sight manipulation test. They varied the mode of administration of KR in three different manners—

(i) By sounding a buzzer when the subject was on target,
(ii) telling the S at the conclusion of trials, how long he remained on the target, and
(iii) giving him specific information on his error tendencies.

They reported that the group which was given KR by sounding the buzzer manifested a marked drop in the performance at the discontinuation of KR. But the remaining two groups showed no decline after the cessation of KR. The studies cited above do show that cessation of KR results in performance decrement, though the performance decrement, so brought about, may or may not reach the initial level with which practice began. Such, however, are not the universal observations. There are a few studies which fail to report decrement in performance after the withdrawal of KR. Such studies are as under:

Biel et al. (1944) (in Ammons, 1956) provided KR by sounding an electric buzzer, whenever S was off the target, in a tracking experiment, but not even the slightest performance decrement was obtained after KR was discontinued. Tufts (in Ammons, 1956)
used college students with gunnery range and height finder. One of the subjects did not show any drop in performance when buzzer, as a knowledge delivering agent, did not sound. Ammons (1956) cited another study by Biel et al., who found no specific decrease in the mean performance of individuals in gun pointing when KR was withdrawn. Madan and Dey (1964) too, did not obtain any extinction after the withdrawal of KR on a task of estimating 7 sec. of time. The authors, while discussing the issue, as to why performance decrement following withdrawal of KR is reported in some experiments and not reported in others, concluded that due to the difference in the control of some important factors accounting for the lack of agreement between experimental findings, e.g., the possibility that certain processes which serve as substitutes for knowledge-giving events are eliminated in certain experiments and not eliminated in others after the withdrawal of KR. Thus, resulting in the performance decrement in the former but not in the latter.