

## Assessment of Learning and Acquisition of Scientific Temper

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**W**E ARE at the end of the year 'World Year of Physics'. It celebrates the centenary of Albert Einstein's 'Special Theory of Relativity' given in 1905. It is said that this theory removes absolutism and brings in the idea of relativism. Every inertial observer has his own time and event simultaneities. No one observer is special in any way. Put another way, everyone is unique! Philosophers say that this (along with other events) has led to ethical relativism. No one wants to take a definite stand against or for any absolute value or principle. But Einstein's theory of relativity also pointed out and discussed invariances and covariances which exist in the universe. Universal and relative concepts live together.

This is what we need to keep in mind when we look at any problem, including Assessment. There is a common level of objectives and aims and at the same time each learner has his own space-time, his own world. These distinctions become very important when we have institutional frameworks for imparting

education. Even in the best of cases, the aims of persons in different segments or layers of the system are not identical. Perceptions vary widely depending on the environment. A teacher is not perfect. She has to worry not just about communicating but also about her students doing well in the examinations. To remove subjective distortions, a fairly inflexible system is set up and adhered to meticulously, almost obstinately. The result is often counter-productive to the aims of education. If the society or the system was perfect, as envisaged by a theoretical model, then there is no problem. However in a realistic, human situation, there are deviations, departures, imperfections, which can be ignored only at our peril. What we need is a perception, an understanding of the deviations (imperfections?) in any given situation. By definition these can not be modeled in an ideal or perfect way.

This is where 'Science Education' ceases to be a 'natural science' and becomes a 'social science' with all its heartaches and uncertainties. We look at the qualitative differences between the natural and social science. Acquiring scientific temper is akin to learning values and is really a part of social science. Science education has very little to do with developing a scientific temper. The discussion will be against the background of the 'Hoshangabad Science Teaching Programme' which ended in Madhya Pradesh a few years ago.

### 1. Introduction

It is ironic that I should have been chosen to speak on assessment. I have

a great aversion to judging people. I have not been on any committee or group involved with the NET examination of the UGC or CSIR or the admission committee in my department. It is not that I have refused to do these things, but I was never asked. Maybe others guessed my reluctance or had doubts about my competence. But somehow I got involved in assessment with HSTP.\* Students were doing so badly that it was decided that they should be marked on the curve. I came up with simple minded analysis of marks which could then be modified to get a decent distribution (sophisticated fudging !). Otherwise all the students were in a pile at the bottom. This was more than 25 years ago. After that the HSTP has grown and I am sure, changed. I do not know if the analysis was changed, modified or continued. Anyway that is the only justification for my standing before you, talking about assessment in schools. Of course, I have been forced to assess my own students at the university.

My first observation follows naturally from what has been said above. The source group in HSTP had (or liked) to do things they were never qualified for, but had secretly wanted to do ! We had people getting interested in drawing sketches, designing book lay outs etc. In many cases their efforts were very creative, good and successful. That is something the formal systems never encourage or permit. I think that is a plus point for People Science Movements like HSTP.

## **2. Imperfect Institutional Frameworks- Need More Assessments**

My main theme in this talk is that the time has come for the workers in the field of education to go to the second stage. The first stage was to agree on child centering. The National Curriculum Framework (NCF) has already done that. However, child centering is an ideal concept. It requires perfect conditions, low student teacher ratio, highly qualified and motivated teachers etc. Going to the second stage is to recognise the imperfections and try to work in a non ideal system. A lot of optimisations will have to be done. We might recall that whatever progress the subject of economics has made, is because of the recognition of imperfect markets and imperfect competition, and not working with the idea of a hidden hand of Adam Smith. A physical law is same for every observer but each observer uses his own space- time to work in.

Start with an example. A class has 30 students instead of 5 or 6. Then :

- It is necessary to have students in groups of 5 or 6.
- One needs attendance registers
- One needs submission of class and home work and its correction and evaluation.
- One needs periodic and final evaluation.

None of this is needed if one had a very small number of students.

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\*Hosangabad Science Teaching Project

Let us take an example from HSTP of 30 years ago.

- Unqualified Teachers
- Absence of Kit
- Ignorance of Decimals
- Non Suitable examination
- Lack of language fluency among students

These were addressed by

- Having monthly meetings with teachers
- Getting involved in designing/ purchasing and distributing Kit.
- Writing and including a chapter on Decimals.
- Designing and conducting examinations in theory and practicals.

Linguistic Ability could not be addressed. It was way out of our ambit. Many other problems were never tackled though one was aware of them. Some of these were

- Parental anxiety about doing well in Medical (PMT) and Engineering (JEE) entrance exams.
- No substantial advantage offered by HSTP in performance in 9th Class and above.

The old system may not be good education but over the years an informal parallel system of well checked guidelines and suggestions has developed on how to score highly in examinations!

### 3. Assessment—An Overview

The topic of this paper is an important part of educational policy and has been discussed ably in the National Curriculam framework (NCF). It may be useful to begin with what they say and their conclusions. By and large they are non controversial.

“Education is concerned with preparation for meaningful life and evaluation should provide feedback on the success in implementing such an education. Current processes of assessing a very limited range of faculties are highly inadequate. Even the limited purpose of providing feedback on scholastic and academic development can be achieved only if the teacher is prepared before the course of teaching with the techniques of assessment, the parameters of evaluation and the kinds of tools that will be employed. In addition to judging quality of student’s achievement, a teacher has to collect analyse and interpret performance on various items of assessment to understand the learning in different domains. **The purpose of assessment is to improve teaching-learning process and materials, and to review the objectives one began with, in the light of capabilities of learners as revealed by testing.** In the evaluation of learning we should also have parameters which encompass creativity, innovativeness, development of the whole being, attitudes to learning and ability for independent learning. Assessment and examinations must be

credible and based on valid ways of gauging learning.” (emphasis has been added and considerable editing has been done)

The examination reform committee, associated with NCF, had recommended Continuous and Comprehensive Evaluation (CCE) coupled with teacher empowerment. The NCF, however, urges caution as CCE places a lot of demand on the teacher’s time and ability to maintain records. This is an example of what I would like to call recognising imperfections on the ground. CCE is both good and bad. Niels Bohr, the famous physicist had several famous arguments with Albert Einstein and often came out victor. He said “A great truth is one for which the truth and its opposite, both are true”. CCE seems to fall into that category. Social science is full of great truths! ( Physics has only a few, like Particle — Wave duality.)

The Examination reform committee also gives suggestions on nature of questions which should be asked. Their detailed recommendations on different ways of testing different classes (in the context of CCE) can be very useful, if not used rigidly or forcibly. It is made quite obvious at various places that making of tests ensuring their reliability, credibility and validity is a specialised job requiring professionals. The scarcity of such professionals is a matter of deep concern in our country. The corporate sector also needs evaluation instruments. They are now coming into the country as part of collaborations with foreign institutions. There is however a total lack of indigenous effort in creating instruments for academic testing.

#### **4. Scientific Temper, Science and Spirituality (or Religion)**

Before we can discuss scientific temper we have to deal with the difference between natural science and social science. ( sometimes referred to as hard and soft science) This requires a brief review of the world view of a person and the place of different types of knowledge in that world view. Broadly speaking, we can talk of an inner and an outer world for a person.

I, the thinker, am at the centre of the inner world. I receive continually, from birth, perceptions which serve to define my world view. Free will or capacity to make a choice is assumed. In deciding or making a choice, one needs a value system, part of which is inborn and part comes from outside due to parental and other societal influences, including, of course, faith or religion. The ordering of one’s perceptions defines a flow of time, a personal time which can be related to physical time of the outside world. Communication with the outside world by speaking, listening, reading (use of language ) coupled with logic enables the construction of the outside world. As is clear the centre of description of the inner world is oneself. The details of many of the above processes, like construction of outside world, are subjects of study in themselves. Every generation of philosophers re-examine and write treatises on them.

The *outer world* is the objective or impersonal world which existed before my birth, holds me in it now and will continue to exist after my death. It is the world of physics and other sciences.

Emotion or feeling does not enter into the impersonal description of the outside world. Logic and scientific method (repeatability, falsifiability) are necessary. This world has a universal time and history. It has no preferred or obvious centre and is accessible to every individual through his or her perceptions. Science is related to outer world and decides our knowledge of it, its laws and evolution.

Spirituality is related to inner world. It does not use the scientific method or the intellect directly. If one has to describe it one can say that it is a feeling of nobility, elation, love, bliss guided by emotion or a refined version of emotion, yet seeming to transcend all these.

### **Working of Inner World**

Inner world includes humanities, arts and social sciences and all other areas of outside science. Though this world is not part of science, the scientific method, i.e. logic and reasoning, plays an essential role here. However, repeatability and falsifiability do not exist; as controlled experiments are not generally possible and where possible have large errors or dispersions. Some times the word 'Soft sciences' is used to describe these areas which include economics, sociology, political science, psychology etc. Statistical methods are crucial for their study. To achieve objectivity in the study of these subjects is not easy. Detachment plays an essential role though perfect detachment is not possible. Careful authors declare their individual viewpoints and beliefs to enable the reader to discount subjectivity and bias.

In the inner world heart, rather than the head, is the decider. Love, affection, kindness, elation, ecstasy play big role in decisions. Soft sciences try to deal with such problems in many ways, many of them statistical in nature. There is however the difficult problem of, 'empirical validity'. In the absence of experimental or mathematical proof, validity is by personal satisfaction. One example is 'Music Appreciation'. Here personal satisfaction is a key factor, though opinions of other experts may also play a role. Personal satisfaction is accompanied by elation or happy feeling and decides our choice of good music. The ultimate in personal satisfaction is what is called by different names: peak experience, cosmic religious feeling, self-actualisation, *brahmananda*, etc.

### **Peak experience as a guide to truth**

The peak experience plays as much role in the outer world of science as in the inner world. This is because scientists are human beings and the creative experience spans both the worlds. The role of peak experience in science has however been difficult to grasp in an unambiguous way. Kepler's laws of planetary motion led Newton to give his theory of gravitation. Kepler was in great ecstasy when he discovered his laws and this convinced him of the correctness of the laws. He was right in this case. However, there were many other conclusions he reached, based on ecstasy, most of which were wrong. So it appears that peak experiences have to be subjected to experimental verification

and validated, before their scientific truth can be accepted.

In the inner world there is no such way of validation. One has to live with uncertainty and try to validate conclusions to the extent soft sciences permit you. The acceptance of authority in the real world, however, does not seem to be based on validity alone. It is a mixture of charisma, social importance and the power wielded by the promoter of the idea. Hence use of logic, touch with reality and scientific method to the extent possible, is absolutely necessary to tell us if the 'emperor has no clothes!'

Logic and reason have been part of social science and philosophy much before modern science developed. Modern science has reinforced the use of logic and reason, now under the name of scientific method, in soft sciences. This makes a person question the commands of priests and religious books, reducing the power of the clergy. In the framework given above there is really no conflict

between science and spirituality as they belong to different areas, either outer or inner world. Both are part of my world view, in my mind. There is no body-mind duality.

### **Scientific Temper**

Scientific temper is an attitude to different questions that arise in normal life of a human being. Like believing in superstition, accepting the pronouncements of a religious authority. These are all based on man made rules not scientific laws. 'What your scientific temper is', is hence a part of social science. The acquiring of scientific temper is akin to acquiring values. Science has nothing to do with scientific temper! It is a red herring in science education, though very important for total education. This was seen in the Hoshangabad programme. The real opposition to the new way of teaching emerged only when social sciences were taught differently.