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Developing Self-Instructional Materials for Science Programmes : A Pragmatic Approach

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Teaching-learning transactions in subject areas falling under the umbrella of the 'hardcore-sciences' have been seen to be problematic because of a range of reasons. They could be problems as varied as vocabulary and technical jargon, to pre-conceived belief, structures and prejudices. In this connection the design factors of the SIMs should definitely take the experience of a classroom teacher into consideration. This article deals with the possible ways in which the teacher in a classroom can be transposed to the 'in built' teacher in the SIMs. The article presents a specific point of view. One could take a positive or a sceptical stance towards it. We would welcome comments from those interested in the area of science teaching.

Introduction

One of the major issues pertaining to the design of Self-instructional Materials (SIMs) is the question of flexibility i.e. the presumed ability of a finite instructional package to cater to the needs of a large learner clientele. There are many opinions often conflicting ones at that, on the content and design of the curriculum. Of the many designs available today, perhaps the oldest method is rote-learning. The focus here is *transmission* of knowledge. Knowledge is imparted from the teacher to the learner. Testing takes place on recall, understanding and assimilation of the material. The presentation of material will be determined by the ingenuity of the teacher. It is therefore often remarked that the quality of education reflects the quality of the teacher.

In the distance mode of education the teacher and the learner are physically separated. The teaching-learning transaction takes place by means of:

- SIMS (print, electronic media)
- counselling
- assignments.

While planning the format of SIM, the following questions need to be addressed.

- Is a great teacher one who knows his/her content area well?
- How much of good teaching depends on awareness of/sensitivity to varying learner needs?

In assessing the quality of a teacher, what is the precise balance between knowledge (of content) and mastery over teaching techniques?

The Format of SIMs : A Perspective

In most cases, the content density of the SIMs is relatively high. The effectiveness of the self instructional materials does not depend on the density of content alone. Teaching an adult learner who is physically separated from the teacher and the peer group demands that the teacher be"built into' the materials. Viewed in this light, the content forms only one of the many dimensions which constitute the SIMs. The strategies that a teacher would employ in a classroom to get across the content to learners of varying abilities happen to be an important aspect of the design of the SIMs.

Here a few examples from the case of teaching science to the distance learners are used to illustrate some common pedagogic strategies the ultimate goal of these activities, is to foster in the learner a sense of independence and self direction.

Example I

Consider the following two-lesson sequence (Hill 1988).

Students were asked to bite off and chew a piece of carrot. Questions that follows were: *what teeth did you use to bite off the carrot*? *What teeth did you use to chew up the carrot*? In the next instance students were asked to bite a light card board and tear it off. Next to this a diagram of human teeth was provided and students were asked to mark the teeth for biting, chewing and tearing. Finally the teacher introduced the appropriate language (e.g. incisor, canine). Inquiry approach provides an opportunity to the learner to perform certain task. There is an old Chinese proverb: I hear, I forget. I see, I remember. I do, I understand. Doing helps the learner overcome communication barrier and also it augments comprehension.

Example II

Schwab (1964) argued that the principal focus of science education should be on conceptual clarity, not on the isolated facts, laws and theories on which instruction is all too-often based.

Here is an example to show how an analogue can be used in self instructional materials to introduce a topic like 'Catalyst'.

A king had seventeen horses. The king had written in his will that after his death 1/2 of his horses should go to his elder son 1/3 to the second son and 1/9 to the youngest son. His council of ministers, his death, found the task difficult. The chief of his council of ministers however solved the problem by lending his own horse. Now the total number of horses became eighteen. The 1/2 of 18 i.e., 9 was given to elder son, 1/3 of 18 i.e., 6 was given to second son, and 1/9 of 18 i.e., 2 was given to youngest son. Remaining one horse was taken back by the chief. The role played by the horse of the chief is to facilitate the process of division although it remained

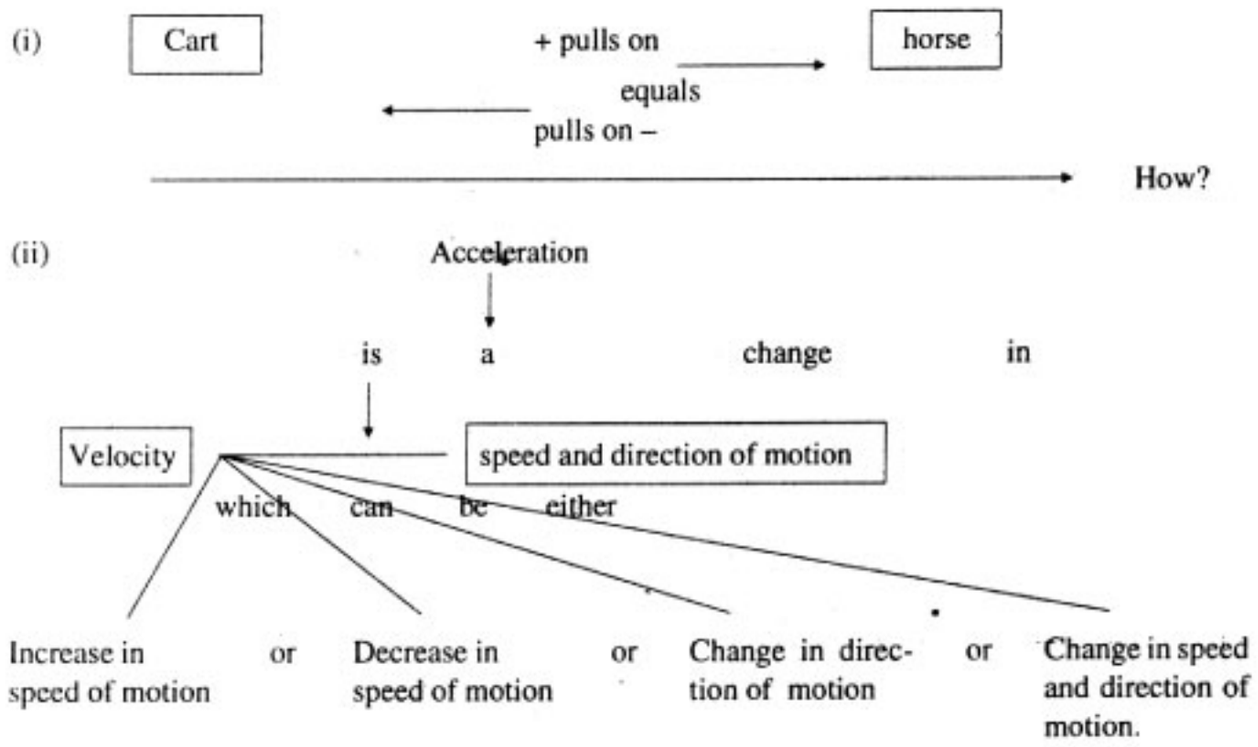
unaffected by the process itself. Likewise in chemical reaction a similar role is played by the catalyst.

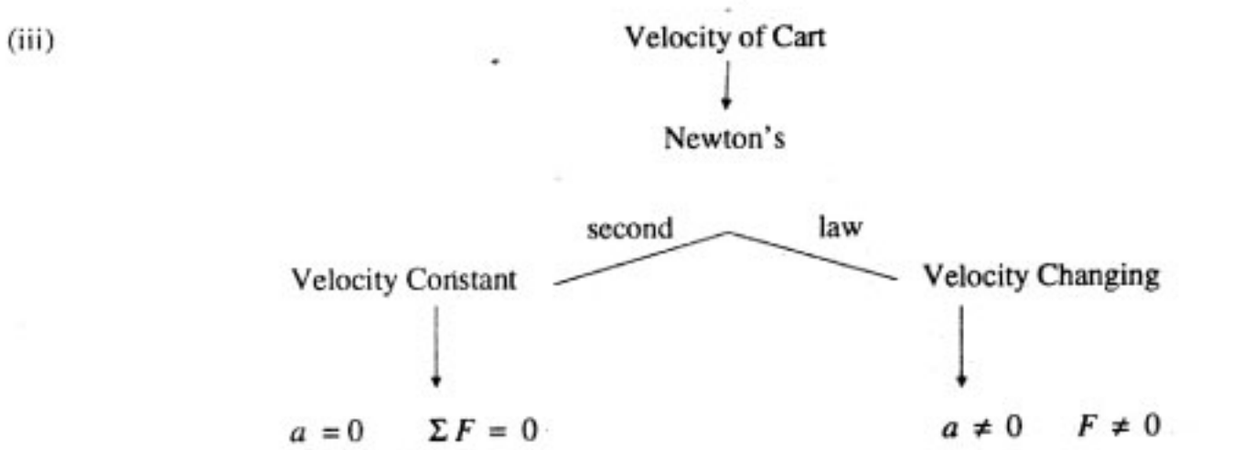
Example III

Champagne and Klopfer (1980) have developed a concept—Structure Analysis Technique. A standard Physics problem given below shows us how such techniques could be used in SIMs for helping the learners structure their knowledge.

A horse pulls a cart along a road. The cart exerts a force on the horse that is equal and opposite to the force the horse exerts on the cart. Explain how it is possible for the horse to move the cart.

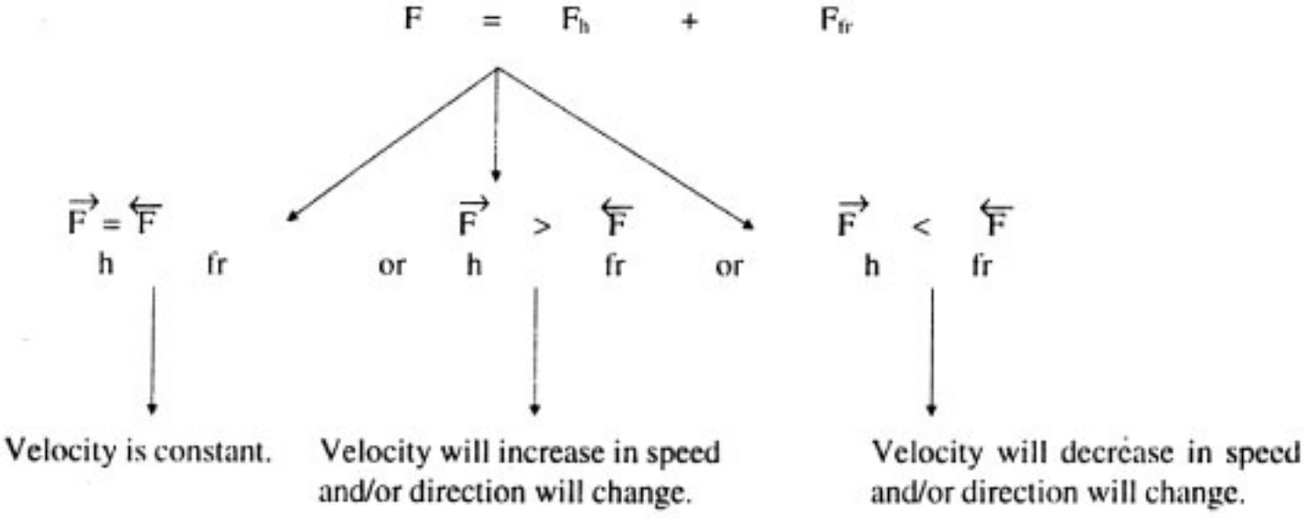
In working out the solution to this problem the SIM can present it with the help of some basic concepts of classical mechanics in the diagrammatic step-by-step process.



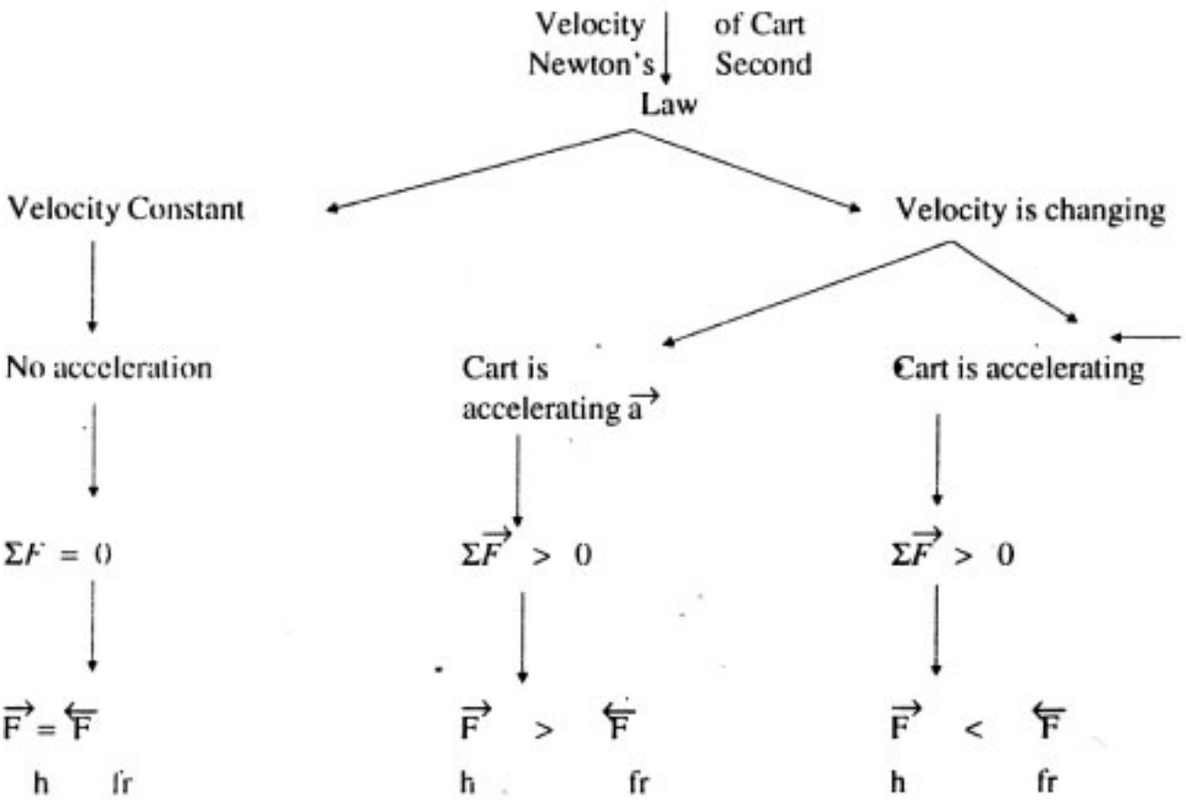


(iv) F_h = force of horse $\xrightarrow[\text{forward direction}]{\text{acts in}}$

$\xleftarrow[\text{backward direction}]{\text{acts in}}$ F_{fr} = force of friction



A diagram can say this succinctly:



This provides the logical procedure for solving a physics problem and also the method of structuring an analytical paragraph that has a logical sequence and clear relationship of ideas.

Example IV

Although science education aims at developing reflective thinking, the need for retention of the optimum quantum of critical information given during the course of learning cannot be overruled. The new information given in relation to past experience is meaningful and therefore retained. An overview of teaching at the memory level shows the usage of familiar, simple, funny and interesting words, sentences, short poems etc., easy to remember. For example, if the position of the planets of the solar system is to be memorized, an instance like this may be quite helpful:

My Very Educated Mother Just Serves Us Nine Pickles

The first letter of each word represents the name of the planet:

M Stands for Mercury

V Stands for Venus

E Stands for Earth

M Stands for Mars

J Stands for Jupiter

S Stands for Saturn

U Stands for Uranus

N Stands for Neptune

P Stands for Pluto

Similarly **VIBGYOR** is another common example to remember all the seven colours of a rainbow in a correct sequence. Such practices are quite prevalent in classroom transactions in areas like mathematics and medicine. You will see that the main focus of all the four examples used to illustrate the main argument has been *the need for contextualised* and *activity-based* teaching. The very essence of the philosophical bases of SIMs is, in a sense, encapsulated in this argument. In turn, the examples highlighted the following:

- the necessity to present the material in graded steps
- the importance of classifying concepts through facts (and not vice versa)
- the need to build links in the total cognitive structure of the learner
- the use of simple devices like acronyms to facilitate retention.

The litmus test of a good teacher is his/her ability to improvise and effect learning, despite varying learner needs and abilities. In the context of SIMs this is achieved through the use of a wide range of activities. The nature and level of the activities will be determined by the content, learner profile and the learning objectives. The presence of these activities accounts for the immense flexibility of the self instruc-

tional package : these activities engage the learners in an active interaction with the text, provide motivation and foster autonomy.

Concluding Remarks

All the selected examples in the present article aims at explaining how best indirectly teaching can take place through illustrations. The cited examples are purposefully meant to be very simple without any subject specific content barriers to make them comprehensible to all. The transactional objective determines the magnitude of the difference between intended objective of any educational programme and the achieved objective of the same programme. A close observation of classroom transaction shows a wide variety of instructional strategies. The modus operandi of a teacher in the class room is the function of multiple Learner Centered Variables.

Therefore, of necessity, the classroom behaviour of a successful teacher remains in the fluid state. It can hardly be crystalised. The teaching is thus aptly considered to be an art rather than science.

The litmus test of a good teacher is the ability to induce learning, irrespective of students' characteristics and background. Though SIM is surrogate of classroom teaching, the possibility remains that SIM is far removed from actual classroom teaching, notwithstanding provided various alternative strategies of teaching built in SIM. The trump card of a classroom teacher is an opportunity to take on the spot snap decision regarding the strategy of teaching. In self-instructional material to give the feeling of the presence of teacher, the supplementary reading material and the teachers handbook are to be developed and utilized as and when required. This makes the educational packages truly flexible that suits the individual need of the isolated distance learner.

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