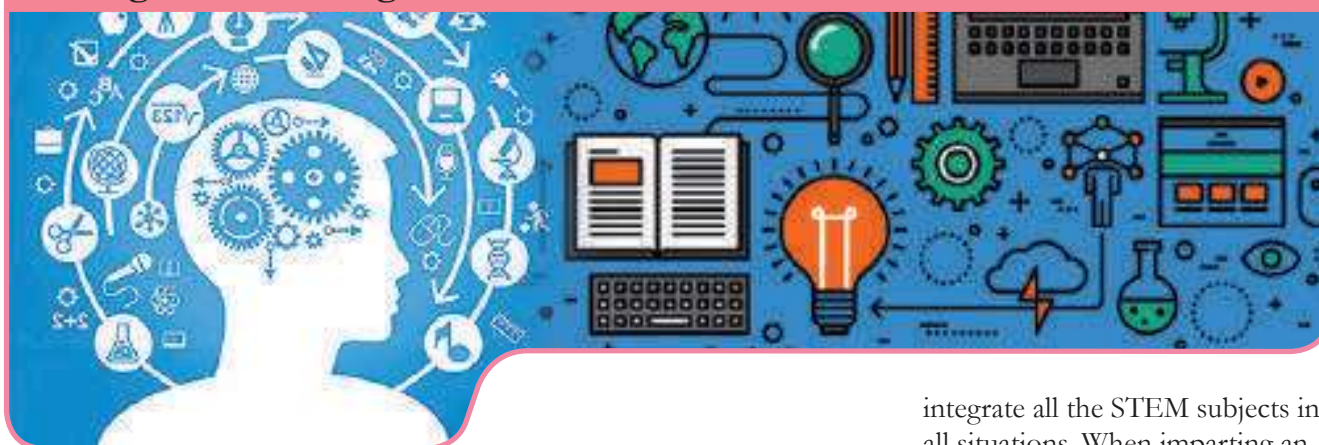


## How could STEM Educational Experiences be Achieved through the Existing Science Curriculum

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Even though education associated with the subjects of science (S) Technology (T) Engineering (E) and Mathematics (M), had existed for quite sometime, STEM education had received special attention only in the decade beginning with the year 1990. The emphasis during this early period was focused on improving and developing each of these subjects independently of each other.

Although action was taken to develop these subjects individually to higher standards in separate compartments, the result especially in the western world was for the student population to gradually move away from STEM education. There was also a continuous breakdown or decline of their motivation to study these subjects. But in actual fact it was predicted that in the near future there will be a shortage of the STEM workforce, and many nations believed and expected that economic development of a country can be achieved by overcoming this shortage. Most educational researchers in the world have shown that it is necessary to provide the students with STEM Education experiences in an

integrated form in order to realize this expectation more efficiently and successfully. Presently it has become a debatable issue as to how this integration should be carried out so that the students get STEM education experiences of a high standard. Many scientists have indicated that in order to solve the above problem related to STEM education, the method should be that the subject curriculum has to be presented as a way of solving the real problems in the world. When presented on this basis the content of the subject curriculum now presented in a compartmentalized manner, the students invariably tend to suitably integrate and adapt the subject content to find solutions to problems as relevant. In other words, through STEM education it is possible to provide opportunities to the students to find solutions to problems in the real world by integrating the compartmentalized subject curricula or content. However it is essential to overcome the misconception that it is possible or compulsory to

integrate all the STEM subjects in all situations. When imparting an integrated education, integration of a minimum of any two or more STEM subjects, or integration of any other subject or few other subjects with STEM subjects is possible.

In developed countries as well as in developing countries in the world, subject curricula have been already developed leading to STEM education. Simultaneously action is being taken to bring these experiences to the students through various techniques. In Sri Lanka, the manner of taking



## How could STEM Educational Experiences be Achieved through the Existing Science Curriculum

STEM experiences to the students through the normal education process is still at the discussion stage. However, Sri Lanka which is dreaming of a knowledge based economy, should not postpone action to create opportunities to bring STEM education experiences to the students through the existing general education process.

Therefore a quick way of bringing the STEM education experiences to the students is to identify the suitable subject content in the existing secondary grades in the school, based on the basic concepts referred to earlier of the integrated STEM education, and to plan integrated activities for the STEM subject content. To understand the various concepts, basic principles, and theories many activities have been proposed. However such activities have been limited to understand specifically the scientific concepts only, and mostly confined within the school. Therefore if the teachers choose a few of the selected items of the proposed activities and decide to conduct them in a STEM education “manner”, then two advantages can be achieved. The first is that because it is proposed to introduce the STEM education approach to the school curriculum in the near future, it will help to orientate the school system as relevant. Secondly, it will create an opportunity to a large section of students who have to leave the school system, to get the STEM education experiences at least to some extent.

Given below are a few suggestions presented to the teachers who are bent on imparting a STEM approach to the proposed activities in the existing science curriculum. This series of suggestions are a set of practices that should be incorporated into the scheduled activities to be carried out in the school so as to give them a STEM approach. In these suggestions, the term practices is used instead of the term skills so as to emphasis



that in a scientific investigation it is not only the skills that are essential but also the knowledge relevant to each of the practices.

### Practice 1 - Questioning and defining the problem

Students in any grade should ask questions about anything they read, any phenomenon they observe, any conclusion reached based

on a certain model or a scientific investigation. Also they should ask questions about the problem they have to solve. They should define more specifically the problem they have to solve by asking questions regarding the obstacles that arise, the limitations encountered when trying to find solutions by following the methods planned by them. Opportunities should be created for the students to ask questions of the type as stated above when the activities suggested in the teachers hand books and text books are under taken.

### Practice 2 - Designing and using models

In science, models are employed to illustrate a system or part of a system, as an aid to provide explanations, when collecting data for various predictions and to communicate information to others. In engineering, models are used to visualize a design, to improve a design and to determine or test the strength and weaknesses of a design. The above mentioned opportunities should be provided to the students who attempt to find solutions to practical problems, by leading them to develop models and use them. It would be possible to give successful STEM education experiences to the students if the teachers pay special attention to provide the necessary facilities to develop models and use them in a more meaningful way instead of trying to make them understand the concepts using the models.

### Practice 3 – Designing investigations and carrying them out

Investigations are conducted to



explain a scientific phenomenon, or to examine a theory or a design. In the science of engineering, investigations are carried out in order to improve a technical system, or to rectify an error or to select the most suitable solution to solve a problem, from among optional solutions. It is possible to impart the STEM education experiences to students by introducing the scientific or engineering approach as stated above to the scientific activities proposed in the existing school text books or teachers guide. It is extremely important to provide the facilities to lead the students to techniques to collect stronger evidence for whatever investigation they are engaged in, in order to state the targets or aims of the investigation, to predict the result and come to conclusions. Also opportunities should be created for the students in the higher grades, so that the students are able to identify the independent,

dependent and controlled variables associated with the investigation and design the plan and carry it out.

#### **Practice 4 – Data analysis and stating definitions**

It is easy and convenient to communicate to others the data collected by planning and carrying out investigations through presenting the data to bring out some pattern or relationship. Since the basic data collected provide only limited information, it is extremely important to analyze the data by presenting them as tables,

or graphs or by statistical methods. It is essential that students should be guided to analyze and state definitions with the aim of proving the conclusions associated with the problem. For this purpose opportunity is available to the students to suitably apply the mathematical knowledge acquired by them by this stage. Accordingly students get an opportunity to integrate science and mathematics.

#### **Practice 5 – Applying mathematical and numerical thinking**

Using mathematics to illustrate physical variables and the relationships between them, and also to make quantitative predictions are practices that should be developed in science students. Besides the practices mentioned above mathematical applications such as logic, geometry and calculus in the higher grades can

be seen in the fields of science and engineering. Using mathematics is a more forceful and efficient manner to solve the problems in the fields of science and engineering. There are many opportunities suitable in the modern world for the use of computers and other digital components to solve the problems in the fields of science and engineering. Accordingly teachers should take steps without delay to make available to the students computers and other digital components in order to make observations, to take measurements, to record data and to process the data not only when carrying out scientific activities in the school but also when solving real life problems.

#### **Practice 6 – Presenting explanation and designing solutions**

In science stating the causative factors or suggesting explanations for various phenomena is constantly taking place. Therefore students should be led wherever possible not only to give their own explanations, but also to forward accepted explanations they have acquired through learning the subject. Attention of the teachers should be directed to encourage the students to carry out activities aimed at giving experience to them to arrive at conclusions, after collecting data and interpreting them, subsequent to investigating a particular problem using scientific concepts, principles, laws and theories.

In engineering more attention is placed to find solutions rather than to put forward explanations. Here emphasis is specially to point out

## How could STEM Educational Experiences be Achieved through the Existing Science Curriculum

the constraints associated with the solution, and indicate the criteria regarding the expected quality of the solution or the product made; develop a design/plan of the solution; examine models and improve the design or model to an optimum level. Thus when students are engaged in finding solutions to a problem teachers should be specially cautious to provide the opportunities to improve the aforementioned qualities. Thereby it will be possible to impart more meaningful STEM education experiences through the science subject.

### Practice 7 – Debating giving evidence

Providing an explanation to a problem or supporting a planned solution giving reasons, or arriving at a consensus through argument and reasoning is an anticipated practice that should be cultivated in students through STEM education. Thereby it is possible to arrive at the best explanation or a planned solution. This also trains the students to engage in comparisons and evaluation of opposing views to the best of their ability.

### Practice 8 – Acquisition of information, evaluation and communication

Practices such as obtaining information from various sources such as books, magazines, internet and media without limiting oneself to one source; being able to identify the clearly outstanding views and possibility for the existence of errors according to the methodology; making inferences from observations; using different views to provide explanations and the ability to differentiate,

are essential when handling information related to science and engineering. Understanding and knowledge of language style, vocabulary and the use of technical terms specific to each field of subjects is also extremely important. This understanding is equally important not only for the acquisition of information, but also for evaluation and communication purposes. It is necessary to identify the opportunities existing in the science curriculum so as to guide the students to develop their capabilities in the usage of language in the STEM subject areas. This may be practiced through writing essays, taking part in debates, delivering lectures and making presentations. These help to develop meaningful STEM experiences among the students. By enhancing the proposed activities in the existing science curriculum through the integration of science, technology, engineering and mathematics, through the development of relevant practices in the fields of science and engineering, and by taking the aforementioned purposes into consideration student performance would be enriched. They would be motivated to engage in their subjects; they would be successful in finding more suitable meaningful and efficient solutions for day to day problems encountered in the world of work. Therefore one should not wait for the day when educational reforms



with the STEM education label are introduced into the school system, but play an active role to incorporate the STEM experiences into the existing curriculum so that the present student population would enter the world of work armed with better skills, and would be able to face the problems in the real world more successfully.



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